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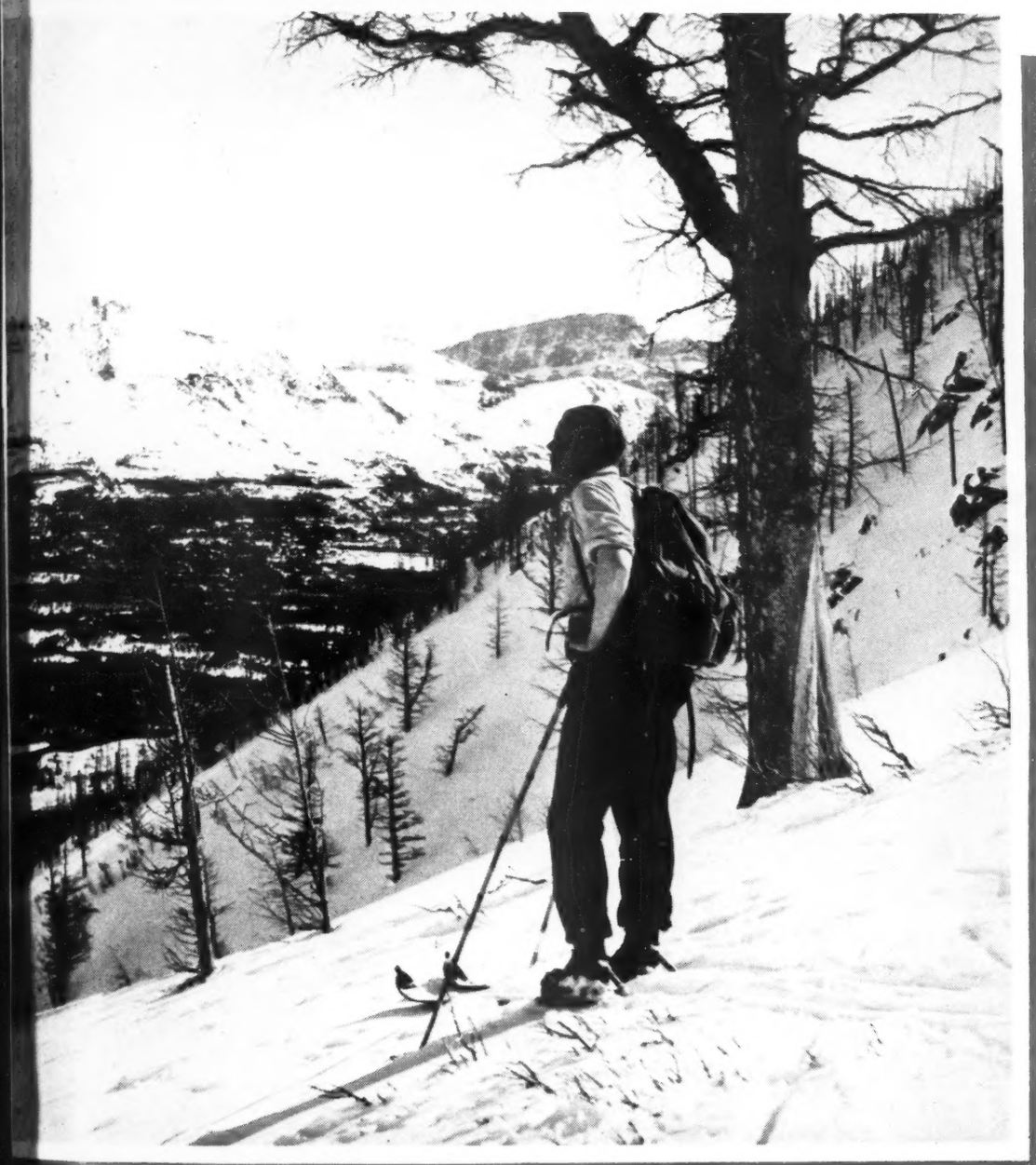

WINTER CLOTHES THE NORTHLAND

A skier rests by an old larch tree on Mt. Saddle in Banff National Park.

Photo, National Parks Bureau, Canada.

VOLUME 52 • NUMBER 2 NEW YORK • LONDON

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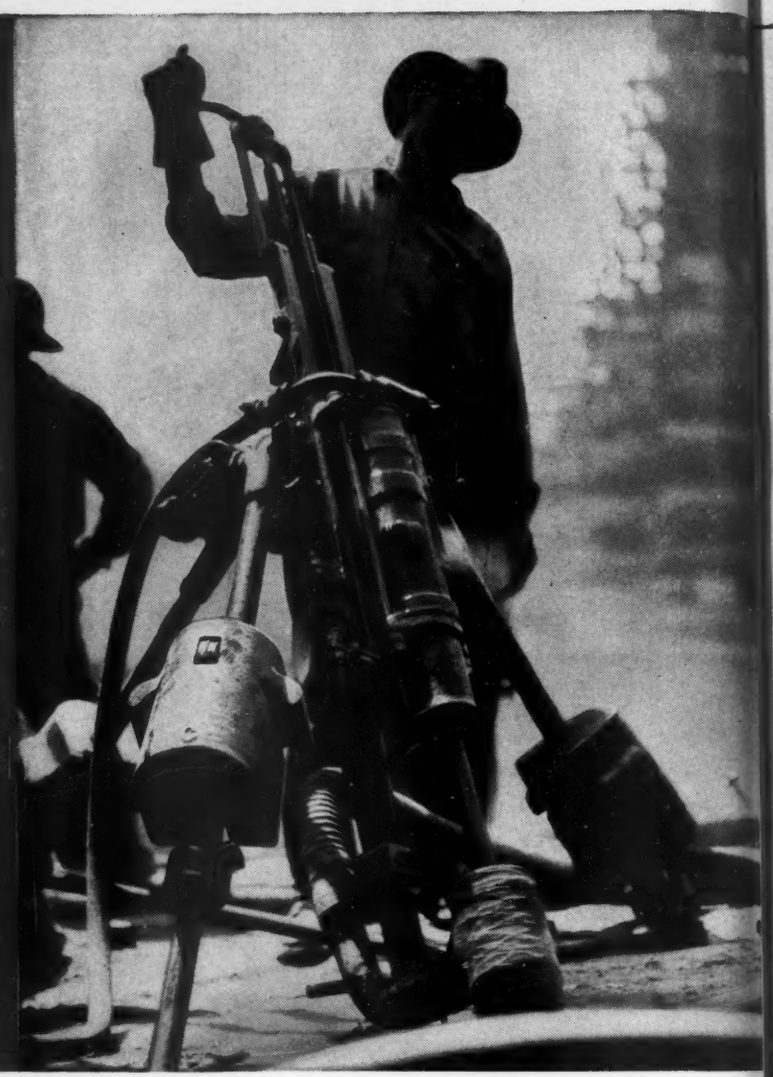

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Compressed Air Magazine

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ON THE COVER

IN THE northern latitudes, winter is a season of great controversy and its calling card of snow and cold is greeted with mingled joy and depression. To all youngsters, winter is a signal for getting out sleds and skates, for having fun and acquiring rosy cheeks and good appetites. To many oldsters, it means snow shovels, automobile chains, overcoats, sniffles, assorted pains, and fast-shrinking coal piles. In the country, snowfall is a thing of beauty, clothing field and forest in glistening, eye-filling garb. In the city, the soot of the air and the grime of the streets soon corrupt it into ugly, splashing slush. Some who have the means to do so emulate the robin by turning their backs on winter and hying southward. Other more hardy souls rush to frolic in Jack Frost's playground. Beckoning to them is the great North Country, where snow really comes into its own, transforming the rolling, wooded terrain into a dazzling white fairyland. Our cover picture shows such an expanse in the Canadian mountains.

●

IN THIS ISSUE

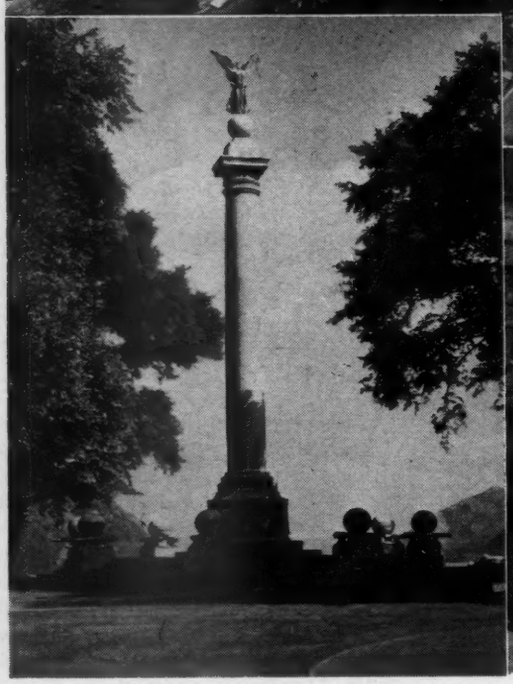
WEST POINT, where Uncle Sam's Army officers are usually trained, is a community of 6500 persons, self-contained and self-governed. World War II increased its importance and its size, and our Government evidently intends to maintain it on a rather generous scale. Among current improvements is provision for a more adequate water supply, as described in our first article.

●

ALL the labor shortage is not in this country, as is made plain by the article starting on page 33. With 300,000 natives employed, South African gold mines are still undermanned. In an effort to keep forces at full strength, they have set up an elaborate system of recruiting native workers and of training and caring for them after they are employed. Much of the material on which our article is based and most of the illustrations were provided by The Prevention of Accidents Committee. Eight of the photographs of natives were taken by L. G. Hallett. The one of the Sotho is by Dr. M. A. F. Helm.

●

WE PAY homage to the memory of Thomas A. Edison in an article commemorating the hundredth anniversary of his birth. On the whole, Edison concerned himself little with the science of pneumatics, but the success of his most acclaimed invention, the incandescent lamp, hinged upon the creation of a high vacuum. Edison didn't devise the apparatus with which this was accomplished, but it is safe to assume that he improved it enough to serve his purpose.



Photos, Public Relations Office, West Point

WEST POINT, the generally accepted name for the U. S. Military Academy, is located on the west side of the Hudson River. It occupies a plateau that surmounts a rocky headland rising almost sheer from the water's edge and is about 50 miles north of New York City. First to recognize the strategic importance of West Point and to urge the erection there of strong fortifications was Gen. George Washington. He realized that the position at a double-angled turn in the river could, when armed, become "the key of the Hudson" and serve to block the movements of any hostile shipping bent upon cutting in twain our new-born nation.

When we started the long struggle for our freedom as a people, few of the colonists had been trained in arms, and some of the men chosen as military leaders were in the same predicament. But there were those among them who had inherent gifts that soon developed to meet the wartime demands made upon them. For example, as early as 1776, Brig. Gen. Henry Knox, an erstwhile Boston bookseller, became Washington's Chief of Artillery and, later, the nation's first Secretary of War. It was he who proposed the establishment of a military school in the United States, and Washington subsequently approved the project. But credit for urging that West Point become the site for such a school is due Col. Thomas Pickering, Quartermaster General of the Continental Army. But pressing demands of the Revolution were to delay action.

It was not until 1794 that Congress got around to providing an educational institution for the Army, and then it authorized the organization of a Corps of Artillerists and Engineers, with two "cadets" to a company—a new grade in the annals of the service. Such a school was later started at West Point, but it was abruptly closed two years afterwards when the buildings were destroyed by fire. What is now recognized as the beginning of West Point as

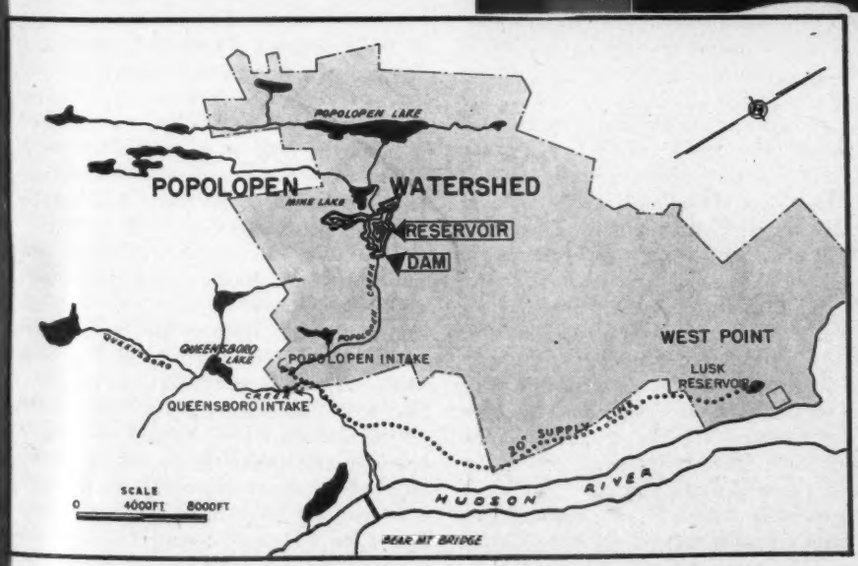
Water for West Point

R. G. Skerrett

our military institution is traced to the Act of Congress of March 16, 1802, under which a Corps of Engineers, consisting of five officers and ten cadets, was organized and ordered to take station there. Nine of the cadets reported for duty; and on July 4, 1802, Major Jonathan Williams formally opened the academy, which has been active ever since. It may be of further interest to mention that West Point is the oldest of our military posts because United States troops have been regularly garrisoned there from January 20, 1778, until today.

West Point's objectives have varied little during its existence and are set down clearly in the following terms of the War Department: "The mission of the Military Academy is to instruct and train the Corps of Cadets so that each graduate shall have the qualities and attributes essential to his progressive and continued development throughout a lifetime career as an officer in the Regular Army." Thus, during the 145 years (1802 to 1947) that have intervened, the institution has contributed conspicuously to the nation's defense by training for our Army forces leaders among whom have been men who have successfully led our armies to victory in the wars we have had to fight since the country attained its independence.

The purpose of this article is not to tell the story of West Point as a military school famous the world over but to describe the steps that are now being taken by the U. S. Corps of Engineers to provide "The Post," as most Army people know it, with a much larger and better supply of water than it has had to draw upon heretofore. To most persons, and especially to casual visitors, the U. S. Military Academy appears to be restricted to the area commonly open to the public, but such is not the fact. With the passing years and growth of the school there have been repeated demands for extension of the original reservation. As a consequence, the property now reaches westward and southward into the hilly and mountainous hinterland until it covers an expanse of 15,000 acres. During World War II, to meet the changed order of training for the cadets, it was necessary to make additional facilities available to supple-



WEST POINT SCENES

An aerial view of some of the school buildings, top-left, with the "Plains" and the Hudson River beyond them. Below it is shown Battle Monument, the sole memorial in our country to the 2230 members of the regular Army who fell in the Union ranks during the Civil War. The structure with cadets standing at attention in front of it is the West Academy Building. At Stewart Field, above, future Army officers receive aviation instruction.

WATER-SUPPLY AREA

Route of existing supply line and location of dam now under construction are shown on map. The shaded area indicates the Military Academy grounds.

ROCK EXCAVATION

Aside from the work required at the dam site, auxiliary construction called for considerable rock drilling. The picture at the left shows blasted material awaiting removal from a stretch of roadway that had to be relocated. Beyond the pile of broken rock is seen the tower of a wagon drill. In the foreground are two 315-cfm. Mobil-Air compressors that supplied drilling air. Below is a scene along the line being drilled for a flume to divert Popolopen Creek during the building pericd.

Photos, U. S. Engineers

ment the familiar parades, drills, and other active military instructions with which the public is acquainted.

So recently as 1940 the authorized strength of the Corps of Cadets was 1960, and there were stationed at West Point 275 officers of the regular Army and about 1200 enlisted men. The latter are selected from the different branches of the Army and are combined at the academy in a single organization designated as 1802nd Special Regiment—the 1802 signifying the year in which the institution was founded. Today, the authorized strength of the Corps of Cadets is 2496, the appointees being drawn from all the States, the territories of Hawaii and Alaska, the District of Columbia, Puerto Rico, and the Panama Canal Zone, as well as from the enlisted men of the Army and the National Guard. Together with officers and enlisted personnel and the families of both, the population of the community approximates 6500. The officers on duty perform administrative and educational functions, while the enlisted men help in running the post and in training the cadets.

West Point, while neither a town nor a village, is, nevertheless, a highly organized, well-equipped, and self-contained community. It has its own hospital, churches, library, and welfare associations; and, for the children at the station, a school that covers all grades from prekindergarten through grammar school. There are also an electric-light plant, water works, police and fire departments, stores, a post office, telephone exchange, telegraph office, a number of athletic fields, and a diversity of recreational facilities. Water is stored in Lusk Reservoir, which is located within the immediate limits of The Point and has a capacity of 92,000,000 gallons—a supply that is none too large, as circumstances have indicated on more than one occasion in recent years.

The little-known region lying back of West Point is far more extensive than the latter and is well suited for the present-day training needs of the Corps of Cadets. In the hills and upon some of its lakes or ponds much field work is carried on throughout each year, especially during the summer months. There cadets obtain experience in the actual firing of regular service ammunition against moving and stationary targets in tactical situations, as well as from all weapons now in common use by the ground forces—the Infantry, the Cavalry, and the Corps of Engineers—and from some employed by the Field Artillery, the Armored Force, and Coast Artillery Corps.

To utilize these ranges to the best advantage a summer training center—Camp Buckner—has been established in the area around and on Lake Popolopen. There instruction is given in pontonbridge building, in ferrying, in the use of assault boats, and in watermanship. Further, the cadets are trained on an obstacle course, an infiltration course, and in amphibious movements. They are taught the tactics of combat in cities and against fortified positions, learn to carry forward attacks under different conditions, are acquainted with the latest types of flame throwers and other pyrotechnic means of overcoming an enemy's resistance, and qualify as military mountaineers and ski troopers.

In addition to the 15,000-odd acres of U. S. Military Academy grounds, there is Stewart Field 7 miles northward near Newburgh, N. Y. That base also is under the jurisdiction of the superintendent of the station and is used as an aviation training center. The cadets are no longer graduated with "wings" as they were during the recent war, but all receive essentially the same basic course, which includes some flying and is designed to give them a knowledge of flight and its practical applications. Thus, by all-around practical experience, a West Pointer is normally ready to be graduated a second lieutenant at the end of four years, although he must still attend the various Army postgraduate schools. When he gets his diploma he does so with the degree of Bachelor of Science, which was authorized for the U. S. Military Academy as recently as 1933.

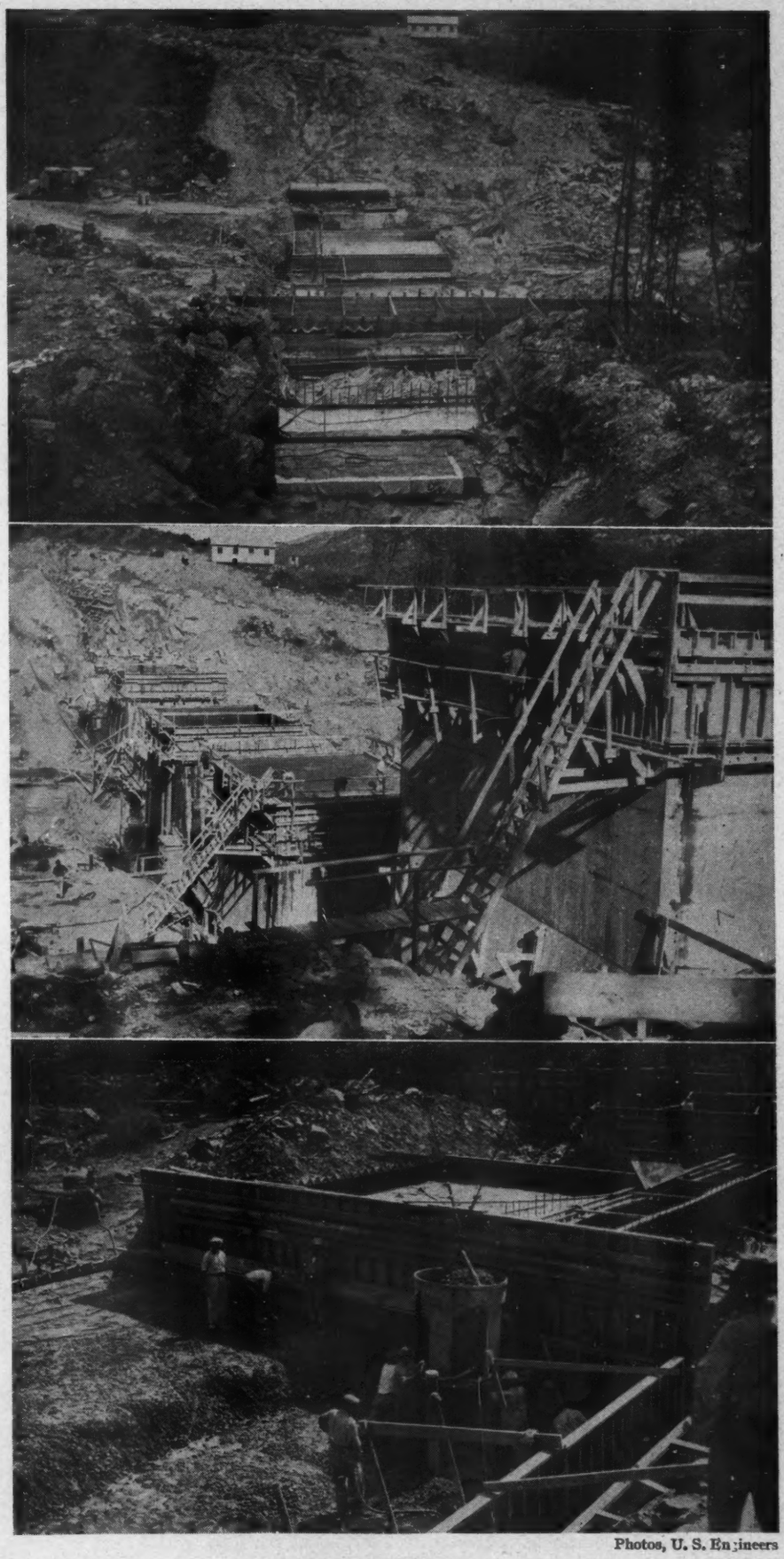
The foregoing facts regarding the reservation's activities and its present population should explain why it needs a larger water supply. However, there is still another reason for this development. The post is contiguous to a section of Palisades Interstate Park, which lies immediately to the south and draws to it annually many thousands of visitors on pleasure bent. Heretofore, the academy and the park have made common use of the waters of certain lakes on the

Popolopen watershed, which is also the source of the water flowing into Popolopen Creek and Queensboro Creek. The latter lies well-nigh entirely within the park, except for a short stretch where it enters the reservation to meet Popolopen Creek. The waters of the two streams then leave the Government property to trace an easterly course to the Hudson River. Some of the flow into Popolopen Lake from the south comes from small bodies of water also lying within neighboring Palisades Interstate Park.

Just before the confluence of Queensboro and Popolopen creeks there is a diversion dam on each stream, and these barriers turn some of the flow of each waterway into a Y-shaped conduit that connects with a 20-inch supply line about 6 miles long. This conveys the water to Lusk Reservoir, within the local area of West Point, whence it is delivered, as needed, to a nearby treating plant from which it is discharged into the post's distribution system.

The demands for water at West Point have increased so much in recent years as to necessitate heavier drains upon certain of the Queensboro Creek group of lakes, as well as upon those strictly known as the Popolopen group. This has tended to interfere with the recreational uses of the affected lakes within the park, particularly during periods of reduced precipitation, and in some ways has also hampered the use of the Popolopen area as a military training camp—especially during the summer when very active work is carried on there. The academy's water requirements have been the subject of exhaustive studies by Alexander Potter Associates, consulting engineers, and two reports were made during 1944 and 1945. The concensus of those findings was that the post should have a daily supply of 4,000,000 gallons to meet present needs and those of the immediate future.

Lusk Reservoir has a storage capacity of 92,000,000 gallons, and there are seasonal conditions when the existing facilities cannot maintain a satisfactory reserve in that basin. The solution of the difficulty lay in a greatly increased storage area at some point on the Government reservation and in abandoning the use of water from Queensboro Creek. To this end, there is now under construction on Popolopen Creek and in the vicinity of Mine Lake a sizable dam that will create a reservoir capable of impounding, when filled to the crest of the spillway, 625,000,000 gallons. Of this, 445,000,000 gallons will represent usable storage capacity, the remainder being classed as "dead storage." The structure is being built under the direction of the U. S. Corps of Engineers. All the water reaching the new basin will come from a drainage area of 12.5 square miles and will be susceptible of control at all stages of the run-off.



Photos, U. S. Engineers

DAM PROGRESS

At the top is a view along the axis of the structure during the early stages of concrete pouring. It shows the wooden flume that was constructed to carry Popolopen Creek over the site. The dam is rising in 40-foot blocks, as shown in the center picture. At the bottom is a close-up of a bucket of concrete about to be dumped. The near man in the form is ready to compact it with a pneumatic vibrator.

The dam site lies about ½ mile below Mine Lake and approximately a mile eastward of scenic Storm King Highway. To reach the field of operations it has been necessary to relocate a section of the Old Mine Road from the Storm King Highway, and that has involved the excavating and disposal of about 6000 cubic yards of rock. This work required the use of heavy Jackhamers and Type FM-2 wagon drills. The rock at the dam site is technically described as metamorphic gneiss, of which 14,000 cubic yards has been removed in making ready for pouring concrete. Most of it has been found to be sound and been excavated with the aid of wagon drills of the class already mentioned. For the deepest holes, penetrating 24 feet, the drills were fitted with 2⅝-inch starter Jackbits. In fact, all rock drilling on the job has been done with detachable bits of different sizes designated as types 1, 2, and 3, depending upon their service with wagon drills or heavy or light Jackhamers. Paving breakers of the CC-60 type also proved helpful, and compressed air for these and for the drills has been furnished by five Model IK-315 Mobil-Air units mounted on four wheels, with pneumatic tires. Each machine delivers 315 cfm. at a pressure of 100 pounds at sea level. These facilities have made it possible for the contractor to meet changing conditions in carrying on his work in a somewhat isolated area.

The construction of Popolopen Reservoir and its associate features was started on December 17, 1945, and the undertaking was scheduled to be completed during the summer of 1947. However, winter conditions have made it inadvisable to attempt further placing of concrete during the cold months. The dam has been described by officers of the U. S. Corps of Engineers as a concrete gravity-type structure. It has a length of 480 feet and a maximum height above the stream bed of about 57 feet, and its ogee spillway is 160 feet long and has a crest elevation at mean sea level of 602 feet, or 15.8 feet lower than the top elevation of the adjoining nonoverflow sections—the one on the north side being 120 feet long and that at the south end having a length of 200 feet. At its base, the spillway is approximately 73½ feet wide, including the stilling basin or bucket at the bottom, and there is a training wall at each side to guide the water in its descent into the bucket. The latter has a maximum depth of about 4¼ feet, is a trifle less than 23½ feet wide, and extends the full width of the spillway. It will serve to slow up the velocity of the water and to discharge it downstream in an arching course so it will fall far enough away from the toe of the dam to prevent troublesome erosion and undermining.

While water is accumulating in the reservoir, the dam must maintain the accustomed flow of Popolopen Creek downstream from the concrete barrier. Therefore, whenever water is not falling over the spillway crest, one or the other of two 20-inch discharge pipes will deliver to the creek a sufficient volume for the 6-mile supply line leading from the diversion dam, 2 miles downstream from Popolopen Dam, to meet the requirements of the civilians resident along the creek and outside the U. S. Military Reservation. The pipes will have their intakes at different levels on the upstream face of the dam and will slope downward through the body of the structure, emptying into the bucket. They will be equipped with suitable valves that may be opened and closed from a control house, which will be a feature of the dam.

Centrally located and near the base of the dam there will be a blow-off pipe 36 inches in diameter and designed so it can be opened or closed from the control house. This also will discharge into the spillway bucket. Its purpose is to permit draining the reservoir occasionally, or disposing of the silt that may collect there. In the future, should it become necessary to impound more water in Popolopen Reservoir, the spillway can be equipped with gates to raise the level and thus increase the volume to a maximum of 1,450,000,000 gallons.

During flood stages of Popolopen Creek, with the basin full and excess water rushing down the spillway, the bucket may possibly be subjected to severe impacts. For this reason the engineers planned to tie that structure to the underlying rock by anchor bolts consisting of steel bars with their tops bent like crooks to hold the bucket securely and to guard against vibration that might induce fractures. Therefore, the bedrock throughout the area has been drilled with holes, 4 feet deep, arranged in parallel lines and on 4-foot centers, both ways. This work has been done with heavy Jackhamers. Into each of these 3½-inch-diameter holes has been inserted a 7-foot steel rod held upright temporarily, or until the hole is filled with grout and the latter has had time to set. Subsequently, the projecting ends of the rods will become embedded in the mass concrete of the spillway bucket. Also in the overflow section and to a depth of 6 feet below the bucket will be drilled pressure-relief holes that will come into play when preparations for the concluding operations within a drainage and grouting gallery have been completed.

The drainage and grouting gallery extends at a low level throughout the longitudinal axis of the overflow section, and for distances of from 35 to 40 feet, respectively, at a somewhat higher level in the flanking nonoverflow sections. This chamber is 5 feet wide and 7 feet high and its purpose is to aid in grouting the rock underlying the body of the dam. Core drills will be used to put down 3-inch-diameter holes spaced 50 feet apart, and the grout pipe will rest on solid rock. Pressure-relief pipes on 20-foot centers will be installed in the gallery, and grouting will be done by the accepted stage method—that is, drilling and grouting successively. All construction joints are to be similarly treated. For this work will be used a grout pump equipped with an automatic pressure regulator, and air to operate this unit and the grout mixer will be supplied by a portable compressor.

The dam rests on a stepped foundation drilled and blasted in bedrock, and the side walls of the abutments are secured to the flanking rocky shoulders of the creek valley. In some sections, where there was any doubt about the rock exposed, keyways were excavated horizontally until sound rock was found. So-called "core walls" will be poured as the dam rises to assure firmer locking to the abutments. Before the job is finished, an estimated 2000 linear feet of line drilling will have been done.

The concrete entering into the dam is provided by a mechanical mixer mounted on a mobile platform and is placed with the aid of bottom-dump buckets handled by a crane that can be shifted from station to station during the upbuilding of each monolith section. The forms, which also are handled by the crane, have an absorptive lining that gives the external surfaces the desired finish. The general practice has been to pour the concrete in 3-foot lifts, and consolidation of the mass is effected by pneumatic vibrators. All told, the structure will contain 20,000 cubic yards of concrete.

While the dam is undergoing construction and before it reaches a suitable height the flow of Popolopen Creek will be carried over the site by a diversion flume—a combination of earth dike and wooden trough 9 feet deep and 18 feet wide. The flume has performed satisfactorily during flood stages of the somewhat flashy Popolopen Creek.

The estimated total cost of the job, including the relocation of a stretch of the Old Mine Road, is $875,000. The two concerns which are working jointly on the undertaking are Gull Contracting Company, Inc., and L. G. DeFelice & Son, Inc. All phases of the project are under the direction of the New York District Office of the U. S. Engineer Department, of which Col. W. F. Heavey is District Engineer. Plans and specifications were prepared under the supervision of Charles K. Panish, Chief of Engineering Division, and Joseph A. Rooney, Chief of Military Construction. Actual construction is under the immediate direction of Lieut. Col. J. C. Lowry, Engineer in Charge, who is represented at the site by A. W. Bury.

Native Mine Workers in South Africa

ZULU

Police work around the mines is popular with Zulus, and many of them, like the one shown here, cultivate mustaches with trained ends. In their native Zululand and Natal the men and women divide occupational tasks on a strict basis. In building a hut, the men cut and set the poles, while the women weave the mat coverings. Men carve utensils from wood, but the making of clay pots is assigned to women. In the fields, the women hoe, but the men plough, as any task involving the use of cattle is their prerogative. A Zulu can be recognized by the holes cut in his ear lobes. A large wooden plug is usually inserted in each hole.

THE gold mines of South Africa's Witwatersrand district employ approximately 300,000 native Africans of whom, roughly, 247,000 work underground and 53,000 on the surface. The recruiting of these men and their training and care after they are hired is a sizable industry in itself. Even in normal times it takes unremitting effort to keep these forces up to full strength, and since the beginning of World War II the problem has been still more complicated. As a result, there is a shortage of help, as is the case in virtually every major gold-mining area elsewhere.

Soon after the first Rand mines were opened a little more than half a century ago it became apparent that more workers would be needed than could be supplied locally, and the foundation was laid for the system of recruiting natives that has been followed ever since. These laborers are now drawn from practically all parts of the southern reaches of the continent; but, as an accompanying map shows, relatively few come from the political subdivisions in which the mines are located.

MINE HEADFRAME

This surface structure serves the south vertical shaft of Randfontein Estates, Johannesburg. The mine extracts, hoists, and mills approximately 12,000 tons of ore a day and employs around 18,000 natives.

Recruiting is done by two organizations affiliated with the Witwatersrand Chamber of Mines—by the Native Recruiting Corporation, which covers the Union of South Africa, Basutoland, Swaziland, and South Bechuanaland, and by the Witwatersrand Native Labor Association. The latter, through its East Coast Administration, functions in that part of Mozambique Territory lying south of latitude 22°, while its Tropical Areas Administration operates in the remainder of Mozambique, in North Bechuanaland, Northern and Southern Rhodesia, and Nyasaland.

One of the difficulties of maintaining adequate mine crews is due to the fact that the tribal natives are primarily agriculturists and do not take to such pursuits as mining without persuasion. Neither do they care to remain long at the work after they have been employed. The average consecutive underground service is only fourteen months, after which the native returns to his home. He may or may not come back, but if he does he will wait about a year. Most of those who toil in the mines do so between the ages of 18 and 40. If they start at eighteen and follow the sequence of fourteen months underground and a

NGQIKA

A branch of the Xosa tribe living in the eastern province of The Cape, the Ngqikas raise cattle. The social life of the men revolves around the cattle kraal, where they do the milking and perform their ritual slaughtering. The women may not enter. The Ngqika pictured is decked in gala attire and carries a goatskin bag trimmed with braid and buttons. The custom of tatooing the abdomen and amputating the last joint of a finger originated in the belief that it insures health and strength.

year of absence they will spend 12½ of the intervening 23 years in the mines. When they reach the neighborhood of 40, the prime of life, they ordinarily retire to the land.

In the territories it covers, the Native Recruiting Corporation engages men under either of two plans, known as the contract system and the assisted voluntary system. Under the first one, each native signs a contract to work underground at a mine of his choice for a minimum period of 270 shifts. The conditions of employment are set forth in detail, and the contract is carefully explained to the prospect. Then he is given a medical examination and, if found fit, is transported to the Witwatersrand with all costs paid. Upon arriving there he is taken in hand by the Witwatersrand Native Labor Association, given a shower bath, and his clothing is disinfected. Another medical examination follows, and if the recruit is accepted he is taken to the Native Affairs Department of the Union Government where the terms of the contract are again explained to him and the contract is registered. With this routine completed, he is sent to the mine he has chosen. If he fails to qualify for either surface or underground work he is returned to his home expense free.

Under the assisted voluntary system, a native who passes the medical examination in his home area signs an agreement to apply for a job at a Witwatersrand gold mine within 30 days, whereupon he is provided with funds to cover cost of transportation. The period of hire ranges from one to six months, and if the man works 270 shifts he is given his fare to return home should he wish to leave.

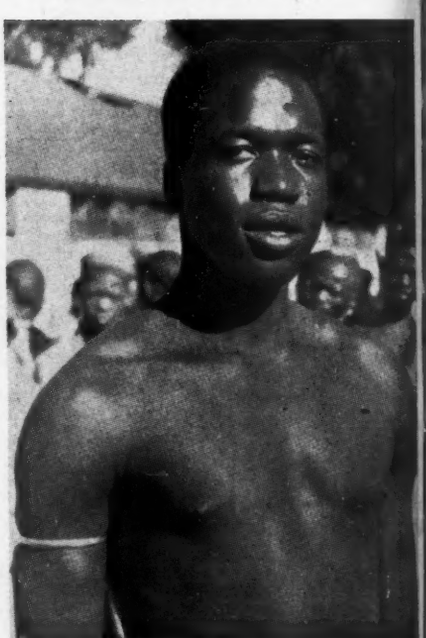
In Mozambique, the Witwatersrand Native Labor Association engages workers for either gold or coal mines of their choosing under contracts conforming with conditions imposed by the Mozambique Convention. These men are known as East Coast Natives. No more than 100,000 of them may be employed at one time. Similarly, natives from the tropical areas are hired under contracts approved by their respective governments and which usually limit their number. These are recruited for gold mines only and will work wherever they are sent. In all cases, traveling expenses to the mines are paid, and upon arrival there the men go through the same routine that has been described.

SOTHO

Living in a poorly vegetated mountainous country in Basutoland and in the adjoining area of Orange Free State, the Sothos have been steeled by an inhospitable climate against hardship and privation and have become resourceful and thrifty. With a crude musical instrument they call their cattle, which are said to recognize certain notes. The Sotho makes his distinctive hat of plaited grass but buys his blankets.

A complete record is kept by the Chamber of Mines of the movements of every native to and from the mine areas, and in an average year some 700,000 are transported. To carry on its operations, the Witwatersrand Native Labor Commission has a staff of 200 whites and 2500 natives distributed among 121 offices in the various territories covered. For administrative purposes and for moving the men, it maintains 50 automobiles and 127 trucks, as well as twenty barges on the Zambesi River and three steamships along the coast of Mozambique. To further its activities, it has opened up hundreds of miles of roadways in previously inaccessible areas, and it finances their upkeep either wholly or in part. During 1945 this agency engaged 100,449 workers, while the Native Recruiting Corporation hired 74,273. The latter has a field staff of 153 whites and 594 natives in 121 branches and maintains 127 automobiles, trucks, and buses.

Despite these well-organized efforts, the mines operated in 1945 with a shortage of approximately 17 percent in native labor, as compared with the peak year of 1941, and this was reflected in a drop of 12.4 percent in tons of ore milled, of 15.2 percent in ounces of gold produced, and of 12.9 percent in revenue. In 1941 there were 367,400 native employees; in 1945 only 306,600. The present requirement of the Rand properties, based on full-capacity output, is placed at 340,000, of whom 280,000 would be needed underground. There are 45 mines in operation, and one of them—Randfontein Estates, which crushes an average of 370,000 tons of ore monthly—has 18,000 natives on its rolls.



CHOPI

The Chopis, who live in Portuguese East Africa, are accomplished dancers and players of the timbila, a primitive but musical form of the xylophone. The word "Chopi" means "to draw the bow" and, though of recent origin, betokens their former expertness in archery. Chopis are fish and rice eaters and make bark cloth and wooden goblets. They distill alcohol from the fruit of the cashew tree and from manioc tubers.

NKHONDE

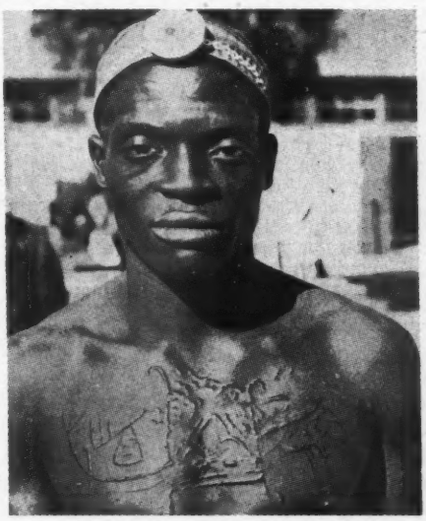
The Nkhondes come from the northern end of Lake Nyasa and southern Tanganyika. The soil is so fertile and rain so abundant there that two crops a year are often raised. Their houses are built of reeds and grass, shaded by overhanging banana leaves, and are usually unplastered to admit air. To safeguard their cattle against theft they take them in their houses at night.

Besides recruiting adults, the industry seeks to augment its future labor supply by training youths who express an interest in the work. These lads are drawn from near and far and enrolled in Government Miners' Training Schools with the status of apprentices. Thirteen branches are located in different parts of the Rand mining district, and each is allotted a section of a mine which the students work while undergoing training. Although some revenue is produced, the schools are not self-supporting. The Government pays two-thirds of the deficit and the Chamber of Mines one-third. In addition, the youths are taught through lectures and demonstrations.

The capacity of the schools is 1800, of whom about 800 can be accommodated in hostels built and run by the former. When the war broke out the rolls were filled, but with the demands of the armed services and other industries the number fell to around 200. The training period is normally two years, but apprentices who show unusual aptitude may be turned out any time after eighteen months. A variation of this system has recently been instituted for ex-servicemen who desire to take up mining. Students up to 30 years of age are accepted, and the course is intensified to turn out practical miners in one year. Last fall approximately 1000 young men were receiving this training.

Special attention is given to training operators for the hoisting plants, and as early as 1904 a scheme of apprenticing was established for this purpose. In 1937 the matter was placed under the direction of the Government Miners' Training Schools. The course lasts eight months, and students are taught to operate boiler plants, as well as winches and large hoisting engines. The instruction qualifies learners to take an examination for a certificate of competency. Of the 2150 who have obtained this certificate since 1896, some 550 have been schooled under the plan inaugurated in 1937.

The increased use of machinery in underground mining in recent years has created a demand for more mechanics. Approximately 5800 are now employed in the Rand mines, and so that there may always be enough to draw upon, men are trained for the work under the sponsorship of the Chamber of Mines. The period of apprenticeship is five years, and includes instruction in prescribed classes at technical colleges.



NYAMBAAN

The term Nyambaan is used around the mines to identify the natives from the district of Inhambane in Portuguese East Africa and from along the Sabie River. They are fond of music and dancing and are good fishermen and sailors. Many of them, like the one shown, exhibit signs of Arabic influence in their features. Note the tatoo marks on the man's chest.

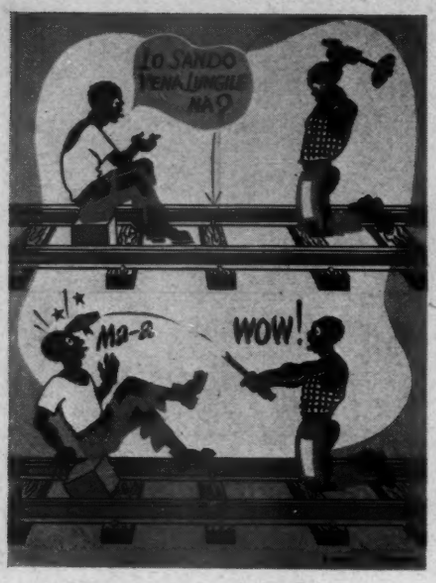
The matter of labor supply is closely related to the continuing success of the mines. As is true the world over, South African gold mines have been ground between economic millstones since the war broke out. With the price they receive for their product fixed, they have seen costs gradually rise and reduce the margin of profit. Some properties have been forced to close, others are being hard pressed to avoid deficits. Although the gold content of the ore varies from mine to mine, all Rand deposits are of comparatively low grade and profit depends largely upon maintaining high output at low unit cost. Any appreciable drop in tonnage is quickly reflected in less profit per ton. Every effort is therefore made to keep production high, and this cannot be done unless the labor supply is sustained. The industry realizes that it cannot reduce wages in these times; it has, in fact, increased them.

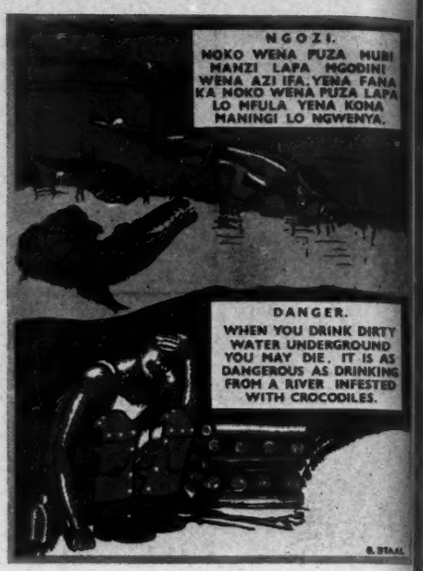
In 1944, European and native employees received 32,000,000 pounds sterling, or approximately one-third of the mining revenue. In addition, the value of social services such as benefit funds, pension plans, accident insurance, and workmen's compensation totaled 3,-800,000 pounds sterling. The mining industry is greatly perturbed over the situation and is seeking relief from taxation to ease its position. Its tax bill for 1944 was 19,250,000 pounds sterling. During the five first war years it contributed 141,000,000 pounds sterling in direct taxes, or 28 percent of the total Union Government receipts.

The life the native miner leads is more or less shaped for him. He is housed in a compound with weatherproof rooms that are lighted by electricity and adequately heated in cold weather. Every compound has hot and cold shower baths and is surrounded by lawns and gardens. Separate quarters are provided for married men and their families. The food is prepared by competent kitchen staffs and exceeds in nutritive value the scale laid down by government regulations. A balanced diet is served, and Africans invariably gain markedly in weight dur-

YAO

The Yaos, who hail from Southern Nyasaland, are very adept at learning trades and develop into good mechanics. The tribal markings are three vertical cuts on the temples, but this practice is seldom followed by members brought up in the Mohammedan faith, such as the one shown here. The women favor tatooing various parts of their bodies and often wear a nose button of lead, bone, or wood.




NGOZI.
NOKO WENA PUZA HUBI MANZI LAPA MGODINI WENA AZI IFA. YENA FANA KA NOKO WENA PUZA LAPA LO MFULA YENA KONA MANINGI LO NGWENYA.
DANGER.
WHEN YOU DRINK DIRTY WATER UNDERGROUND YOU MAY DIE. IT IS AS DANGEROUS AS DRINKING FROM A RIVER INFESTED WITH CROCODILES.

ing their period of employment. Breweries in the compounds prepare the national native drinks, *U'Tywala* and *Marewu*, which are issued without cost.

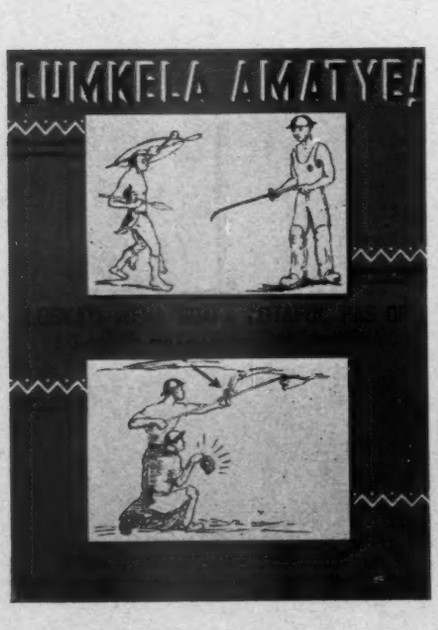
From the time he begins work, the native's health is carefully watched. He is weighed every payday, and if he has lost considerably, doctors investigate to determine the cause. If he is injured or becomes sick, he is hospitalized in a modern institution staffed by trained Europeans and Africans working under the direction of the mine's medical officers. The low annual death rate from natural causes of 2.94 per 1000 attests to the efficiency of the care. Convalescents who are unable to return to the mines are sent back to their homes, expense free, accompanied by hospital orderlies.

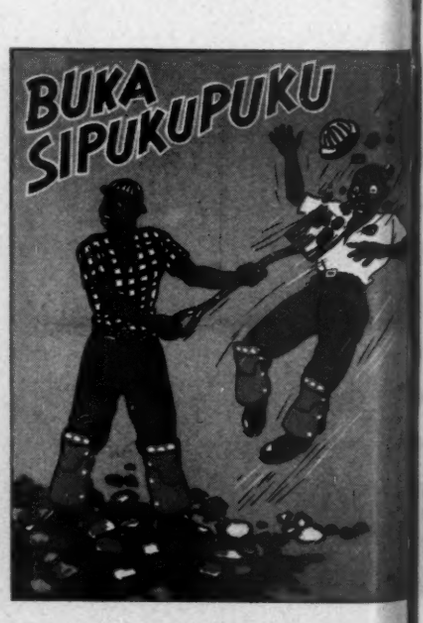
Recreation and sports of various kinds are planned for off-work hours. Free sound motion pictures are shown weekly in 82 mine compounds, seven African quarters for married men, and in three mine hospitals. Attendance averages 2000 per show, and in some of the larger compounds reaches 5000 to 6000. The radio is used both for entertainment and for disseminating news bulletins issued by the Government Native Affairs Department. An African brass band gives week-end programs in mine compounds and provides music for special occasions. Tribal dances are the most popular form of recreation, and competitions are high points in the social life. Football, cricket, and tennis are fostered and drawing more adherents all the while. Trophies are awarded to winning teams and individuals. Boxing is being introduced, and a few tournaments have been held.

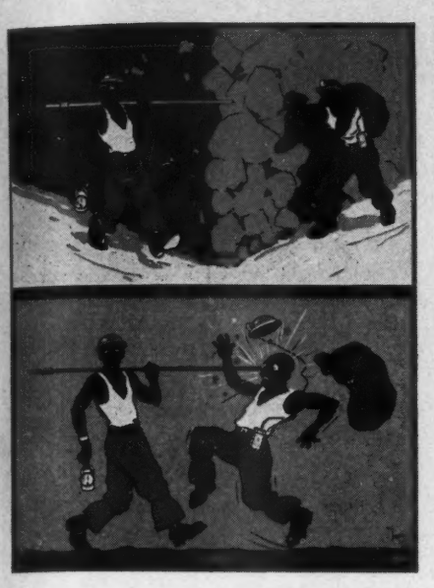
SAFETY POSTERS

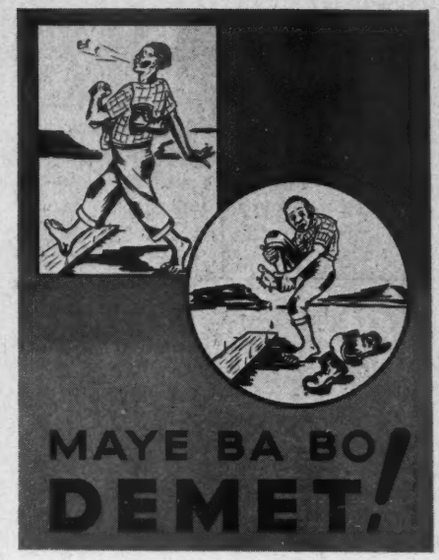
Several examples of the safety posters issued for the guidance of native employees are reproduced on these two pages. As only about 5 percent of the natives can read and some 50 dialects are spoken, pictures rather than words are relied upon to give warning of hazards. The posters are garish with color to attract attention. They are displayed on numerous bulletin boards around the mines and in the compounds and are changed several times a months.

Safety has been stressed since 1913 when The Prevention of Accidents Committee was formed to put an end to recklessness and disregard of mining regulations. The committee has 28 members, and its activities are financed by The Rand Mutual Assurance Company, Ltd., which is allied with the Transvaal Chamber of Mines. During the five years before the committee began to function, the annual accident death rate per 1000 employees averaged 4.29. The average for the next five years was 3.33. Reduction continued, and for the period 1932-36 the rate was only 2.18, with a record low of 2.02 in 1935. Just what this means in terms of lives saved becomes clear when the 1912 and 1936 figures are compared. Had the 1912 rate prevailed during the latter year







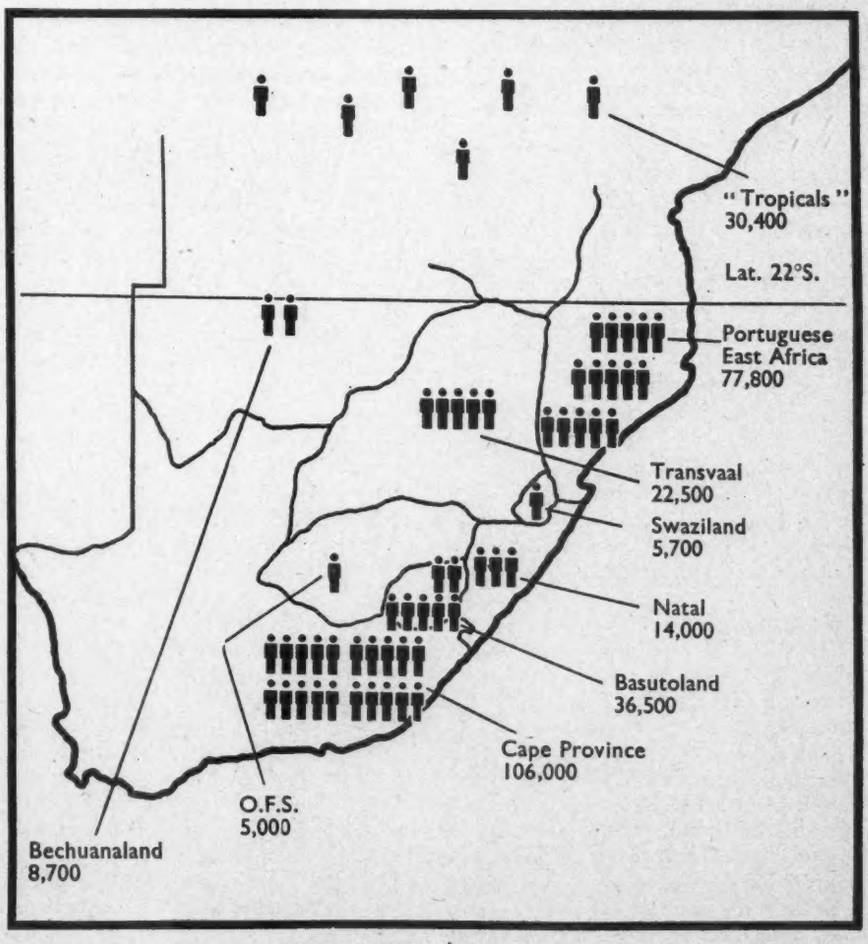


there would have been 599 more deaths than actually occurred. The marked downward trend in the death rate has been achieved despite the fact that working difficulties and risks become greater as the mines increase in depth.

The committee functions chiefly as an educational agency and has three principal standing subcommittees: technical, publications, and prize scheme. The technical group is concerned with instituting and improving safety devices and ideas. It conducts investigations of the causes of accidents, reports on them, and endeavors to suggest means of avoiding recurrences. It also makes recommendations for protective clothing and equipment. Native underground workers formerly wore no shoes and their legs and knees were unprotected, with the result that foot and leg injuries were frequent. Today virtually every man has on boots, sold to him at the manufacturer's cost price, and a great many are equipped with shin and knee guards. All workers in vertical or steeply inclined openings are required to wear hard hats, supplied by the mine, and those toiling elsewhere underground are encouraged to use them.

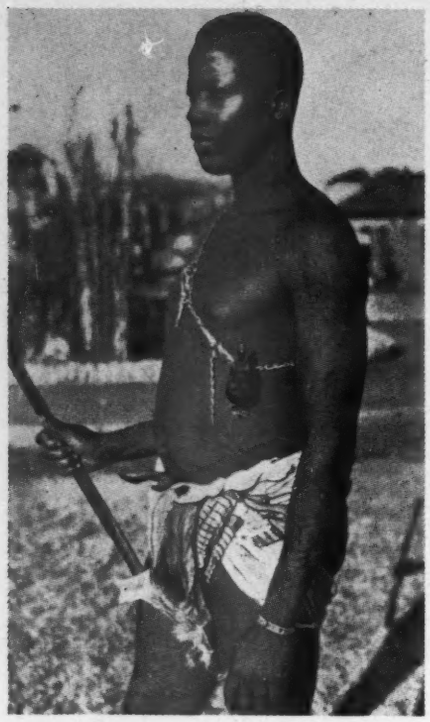
The publications subcommittee issues safety propaganda ranging from periodicals to posters. By means of questionnaires it gathers information about the methods and measures which have been most effective in reducing accidents and prepares reports on them for the benefit of all managers and officials. Most of its propaganda, however, is aimed directly at the workers. Since both whites and natives are concerned, the problem differs from that in most other mining districts.

One of the best mediums for either group is posters. These are 17x22½ inches in size and fit bulletin boards at shaft heads, in change rooms, at pay offices, and in other places where they are likely to attract attention. Experience has shown that underground workers will not read long messages, and even those printed in English for the white employees are kept short and to the point. Posters designed for the natives are distinctive. Only about five percent of these men can read and write, so all appeals are made primarily by means of pictures. Since they think mostly in terms of their homelands, parallels are drawn between dangers that exist there and those they encounter in the mines. For example, an elephant is shown chasing a native in the jungle, and below it is depicted a mine car bearing down on him in a haulageway. His mind im-



SOURCES OF NATIVE LABOR

The figures are for the year 1945 when 306,600 natives were employed. Note that a very small proportion of the workers comes from the Transvaal, where most of the gold mines are located.



NDAU

The Ndaus live in widely scattered villages in Portuguese East Africa. The men are fine archers. They carry a 6-foot bow and usually five arrows, three of which are barbed. They were conquered by the Zulus and adopted the latter's language, but later revived their own. The man is wearing a carved ebony snuffbox on a bandoleer.

mediately grasps the idea that both situations involve the same sort of risk.

The simpler the posters, the more effectively they convey their messages. They bear but few words, for it is difficult to put them in language that all will understand. The basic language of most of the natives in southern Africa is Bantu, but some 50 dialects are spoken there and men from different territories often cannot carry on a conversation. To provide a medium of speech that is workable between whites and natives and among all natives there has gradually evolved a linguistic hodgepodge that is part English, part Afrikaans and part Bantu. It was formerly called "mine kafir," but is now termed "Fanakalo," which literally means, "like this."

The native's flair for descriptive phrases is given full scope in Fanakalo. An epileptic fit is *yenaifa yena vuka*, meaning that a man dies, then wakes up. The gold-bearing ore is *mali*—money—and thus the native senses that it is valuable and must be *layisha*, that is, shoveled into the mine car. Actually, to impress upon him that ore and waste rock must be handled separately, he is told, *ayilayisha la mampara, layisha lọ mali*, or, "a fool and his money are soon parted." If they reduce his pay for some infraction they *bulala lo mali kayena*—"kill his money."

Fanakalo has now been developed to the point where it is issued in dictionary form, primarily for the benefit of new European employees who cannot make themselves understood. As new machines and mining methods are introduced need arises for additional terms, and the dictionary has to be revised from time to time. Fanakalo is put to good but sparing use on posters, and oftentimes messages are conveyed by pictures alone. The native soon comprehends English words that are repeatedly spoken, especially if they are expressive. Such a word is "wow," which, to his mind, connotes fear or pain. It often appears on posters.

Color attracts the attention of natives and is therefore splashed lavishly on posters. New ones are displayed several times a month in compounds, as well as in all places about the mines where the men congregate. Bulletin boards are framed and glazed and some of them are illuminated at night by neon lights or beams that flash on and off. Natives who have been at the mines long enough to acquire some education take delight in exhibiting their knowledge by explaining posters to newer arrivals.

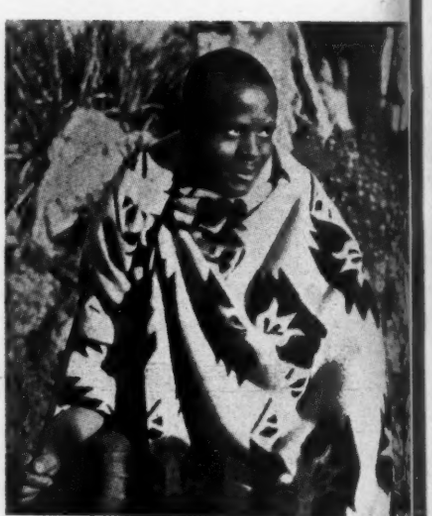
In addition to posters, booklets on safety, also largely pictorial, are distributed. Loudspeakers in the compounds are likewise used to advantage in promoting safety. Many messages are broadcast by means of records and are interspersed with music. Sometimes mine managers or officials address the natives personally, especially after there has been an accident with which they are familiar. The reasons for the mishap are explained and the lessons to be learned from it are pointed out. From its inception, The Prevention of Accidents Committee has taken the stand that "accidents do not just happen; that each arises from a definite cause; and that most of them can be prevented."

Many publications in English are issued for the white workers. These have an indirect effect on the natives, as supervisors and others have occasion to pass along something that they have read in them and that pertains to a situation encountered in the work. Foremost among these is an illustrated magazine, *The Reef*. It was founded in 1915 and has been growing ever since. Published monthly, it is distributed free and is of such recognized interest that it is extensively used by advertisers. Calendars with pictures also are printed annually and always bear safety messages. Care is taken to make them attractive so that they will be kept and displayed.

Still another medium of spreading the gospel of safety is the motion picture. Reels are prepared for both whites and natives and cover all phases of the operations. One of them dealing with the dust hazard underground was produced in 1921 and is still timely. Suppliers of explosives coöperate in the safety campaign. Some 30 or 40 messages, all short, have been printed in English and Afrikaans, and one of them is included in every box of explosives so that it will be seen by the men who do the blasting. As many as 2,500,000 of these placards are sent into the mines in the course of a year.

The prize-scheme subcommittee sponsors an annual safety competition among all properties employing more than 500 persons. The contest has been held each year since 1915, and it is considered a great honor to win it. A safety shield serves as a trophy for the victorious mine, and all underground officials of that mine receive suitable cash awards or mementos.

Allied with the safety movement is the development of mine rescue teams and first-aid and ambulance work, all of which are open to both white and native employees. First-aid training is conducted by the African Red Cross, and the natives have shown great interest in qualifying for the service. Competitions are held regularly, and cash prizes and medals are presented to the winning personnel. All natives who qualify for team membership automatically receive a bonus for every shift they work. Approximately 30,000 of them pass the tests each year, and the total number trained to date exceeds 260,000. The first-aid knowledge acquired by these men is of great benefit to their families and neighbors when they return to their native kraals.



HLUBI

The Hlubi is one of the largest of the Bantu tribes. Its original habitat was Zululand, but its people were split and widely scattered by wars with neighboring tribes. The man pictured is dressed like the Basutos, among whom he lives. Many of the native clerks employed at the Rand mines are members of this tribe.

The Edison Centennial

THIS month marks the hundredth anniversary of the birth of Thomas Alva Edison, perhaps the greatest inventor of all time. He was born on February 11, 1847, in Milan, Ohio, and died in West Orange, N. J., October 18, 1931. Seventy-two of the 84 years he lived were packed with prodigious activity, for he started working at the age of twelve and continued with unremitting zeal until his death. When he was 70 and someone suggested that he relax, he remarked that he would think of taking it easy when he reached 100. "My desire," he said, "is to do everything within my power to further free the people from drudgery, and create the largest possible measure of happiness and prosperity."

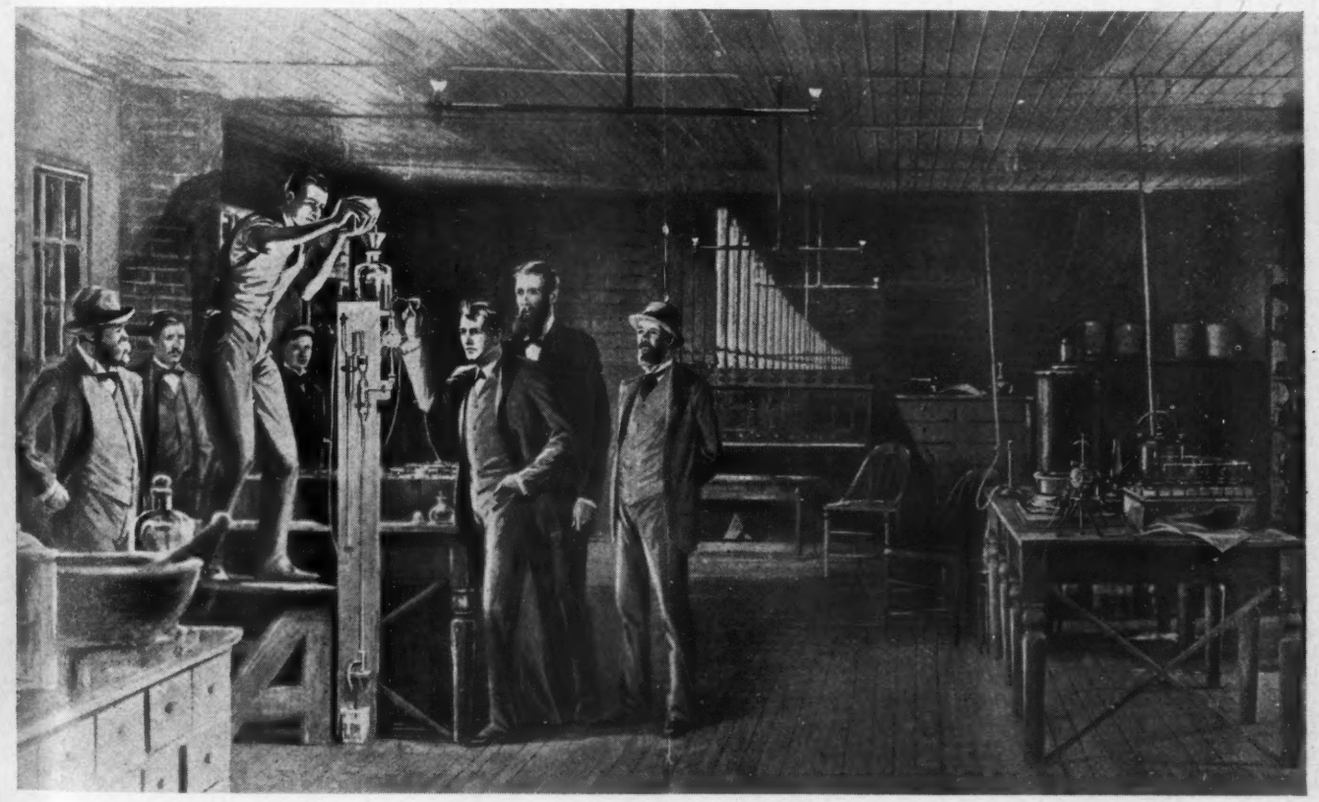
Edison was granted a total of 1097 patents, by far the greatest number ever issued to one person. His most acclaimed invention was the incandescent lamp; his own favorite, the phonograph. Although he worked in many fields, 356 of his patents dealt with electric lighting and power distribution. Always he sought to create things that were wanted —a lesson he learned with the first patent he received when he was still in his teens. On that occasion he devised a machine for electrically counting and recording the "Aye" and "Nay" votes of a legislative assembly. He found he couldn't sell the idea because legislators were not interested in speeding up their procedure.

After he got over his first financial bumps, he regarded money only as a tool with which to work toward ever greater achievements. He developed the fluoroscope, but declined to patent it, choosing to leave it to the public domain because of its universal need in medicine and surgery. When he was still comparatively poor a lawyer, to whom he had entrusted the filing of applications for 57 patents, appropriated the papers and sold them to his competitors. He never revealed the lawyer's name, and when associates pressed him to do so he replied: "His family might suffer."

Edison's forebears lived in England and, later, in Holland. The first of his male ancestors to reach America was John Edison, who arrived as a boy of three about 1728 with his mother and a group of Dutch immigrants. The family had been important millers on the Zuyder Zee in Holland. They settled near Caldwell, N. J., where their home, now nearly 200 years old, still stands. John Edison, the inventor's great-grandfather, was a farmer and married in 1765. He remained loyal to the British crown during the Revolutionary War and was sentenced to death for high treason. However, after spending many months in jails the sentence was commuted, and at the end of the war he was evacuated to Nova Scotia with other Loyalists.

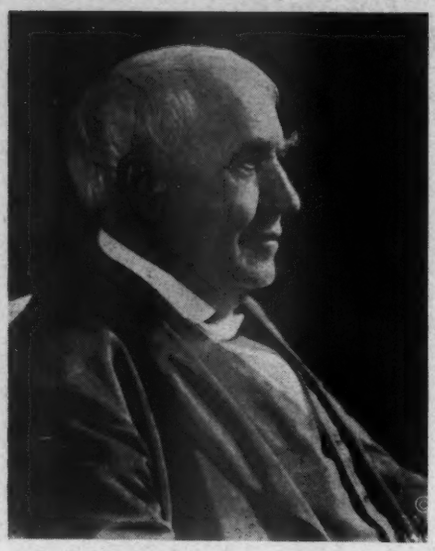
John Edison's eldest son, Samuel, was wed in Digby, Nova Scotia, and his wife bore eight children, among them Samuel, Jr., who was to become the inventor's father. Before that time, however, the Edison tribe, headed by the Tory patriarch John, decided to join in a general exodus from Nova Scotia. In 1810 they all traveled westward by wagon to Bayham Township in Ontario Province, where they helped found the village of Vienna.

The younger Samuel grew up in Vienna, and in 1828 married a school teacher, Nancy Elliott, daughter of the Rev. John Elliott. Ten years afterwards he was forced to flee for his life because of his participation with the forces of William Lyon MacKenzie in the short-lived Papineau Rebellion against England's rule of Canada. Leaving his



BIRTH OF THE INCANDESCENT LAMP

Lack of a means of inducing a high vacuum in a lamp delayed Edison's efforts to create a carbon-filament incandescent light that would burn reasonably long before failing. Finally he obtained a Sprengle pump that served his purpose. This unit created suction through the action of a mercury column descending in a tube. The picture shows Edison in his Menlo Park laboratory applying current to his lamp while an assistant pours mercury into the pump. The bulb glowed steadily for 40 hours. The date was October 12, 1879.



THOMAS ALVA EDISON
A portrait of the great inventor made during his latter years.

family in Vienna, he followed the pioneer trails around Lake Erie until attracted by the village of Milan in Ohio. He set up a sawmill there and sent word to his wife to join him. There were three children at the time, and four more were to be born, of whom Thomas Alva was the youngest. Thus the family that had been banished from America for adherence to a king 50 years earlier became reëstablished there through rebellion against a later king.

Thomas Alva Edison's birthright was a family trait—fighting for what it believed was right, irrespective of the cost—and he displayed it many times during his illustrious career. He refused repeatedly to accept prevailing scientific theories as truths until he had satisfied himself through long and arduous experimentation. Where others had tried and failed, he went ahead and succeeded. Had he lacked this nonconformist attitude, the world would have been deprived of some of his greatest inventions.

As a boy, "Al" Edison was mischievous and hard to handle. Before he reached school age he set fire to his father's barn, for which he was publicly spanked in the town square. Inquisitive to an extraordinary degree, he had a passion for finding out things for himself. With that type of mind, he didn't do well in school. When he was seven the family moved to Port Huron, Mich., and he attended classes there for a few months, quitting when the exasperated teacher referred to him as "addled." His mother thereupon took over his formal education, but most of his knowledge was acquired through self-study. In later years seven honorary college degrees were bestowed upon him, and he showed his belief in our school system by sponsoring the Edison scholarships, which were awarded high-school graduates selected annually by means of a national contest.

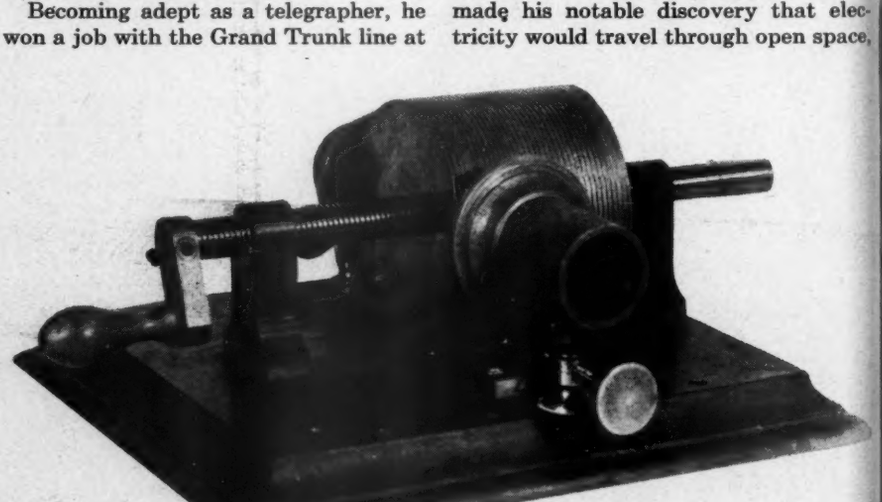
When he was eleven, young Edison had a chemical laboratory in the basement of his home and he had read many serious books, including such tomes as Gibbon's *Decline and Fall of the Roman Empire* and the *Dictionary of Sciences*. A year later his parents permitted him to take a job as newsboy and candy butcher on the Grand Trunk Railroad between Port Huron and Detroit. There he displayed great aptitude for business. In the baggage car he set up his chemical laboratory, as well as a printing press on which he produced *The Weekly Herald*, reputedly the first newspaper ever published aboard a moving train. In addition, he began buying produce from farmers along the route and selling it to Detroit markets. When he was thirteen he was earning several dollars a day—more than most men received at that time.

It was during this period that he became partially deaf, a circumstance that he afterwards said was an asset because he wasn't obliged to listen to a lot of useless conversation and could concentrate on the things he was doing. There is a story that Edison's laboratory caused a fire in the baggage car and that his deafness resulted when a trainman boxed his ears for punishment. The incident was true, but Edison attributed his deafness to the act of another trainman who thoughtlessly picked him up by the ears to help him aboard a train as it pulled out of a station. One day Edison saved the infant son of the station agent at Mt. Clemens, Mich., from death under a moving freight car. To show his gratitude, the agent taught Edison telegraphy. Thus his interest in electricity was awakened and the course of his later life perhaps determined.

Becoming adept as a telegrapher, he won a job with the Grand Trunk line at Stratford Junction, Ont., when he was only seventeen years old. He lost it through his inventiveness. In order that he might nap while at work to make up sleep he lost while studying at night, he devised a mechanism that automatically "reported in" for him in Morse Code every half hour. A supervisor discovered it, and Edison was fired. During the next few years he earned his living as a telegrapher in the Middle West and then in Boston, meanwhile studying and experimenting to improve the crude apparatus then in service. While in Boston he invented his machine for counting votes.

In 1869, Edison arrived in New York, almost broke and in debt. He worked for a time for the Gold & Stock Telegraph Company, and later with Franklin L. Pope in their own electrical engineering company. During this period he conceived the Universal Stock Printer, forerunner of the ticker system that is still used for reporting stock-exchange transactions. He sold it for $40,000. It was the first pay he ever received for an invention, and it enabled him to devote himself to research without having to worry about earning a livelihood. He was 23 years old, and the year was 1870.

Opening a factory in Newark, N. J., for making stock tickers, he included a laboratory. He also retained his New York connections. On most days he worked twenty hours, and his immediate assistants who tried to keep pace with him called themselves the "insomnia squad." When the manufacturing plant began taking more of his time than he wanted to spare from his research he turned its management over to some of his aides, and in 1876 moved to laboratories that he had established at Menlo Park, N. J. But before that transfer he made his notable discovery that electricity would travel through open space,



EDISON'S FAVORITE INVENTION
The original tin-foil phonograph, invented August 12, 1877. The first model that Edison built worked, but he afterwards took out some 50 patents on improvements. The initial recording was "Mary had a little lamb."

a phenomenon that he called "etheric force." He obtained patents in 1885 covering the transmission of signals by induction between a moving train and a station and between ship and shore. These he made available to a personal friend, Guglielmo Marconi, who thereby became recognized as the inventor of the wireless telegraph. Also before leaving Newark, Edison originated the "electric pen," forerunner of the mimeograph machine.

At Menlo Park, having ample scientific apparatus and plenty of trained assistants, he put research on an organized basis. With his own driving force furnishing the momentum, this establishment became the proving ground for a profusion of new ideas and conceptions. One of the first fruits of this activity was the incandescent lamp. Its completion was delayed, however, by the excitement occasioned by the invention of the phonograph, in August, 1877. This occupied Edison's time until July, 1878, when he went to Wyoming to observe an eclipse of the sun and also to test his tasimeter, a delicate instrument for measuring heat transmitted through immense distances of space. Upon his return he resumed work on the incandescent lamp. In developing this boon to mankind Edison made an excursion into the field of vacuum, to which he was to have recourse later in connection with his experiments with X-ray tubes. But his total effort in the realm of pneumatics was small compared with his endeavors along other lines.

Many other persons had tried to produce a workable incandescent lamp; in fact, serious attempts were made to deprive Edison of the credit for the innovation, but they all failed. Even in England, where an English inventor, Joseph W. Swan, was trying to establish a priority, a court ruled in favor of Edison. In his opinion, Lord Justice Fry said: "Swan could not do what Edison did . . . the difference between a carbon rod (as employed by Swan) and a carbon filament (Edison's method) was the difference between success and failure. Mr. Edison used the filament instead of the rod for a definite purpose, and by diminution of the sectional area made a physical law subserve the end he had in view."

The crux of the lamp problem was a suitable low-cost filament that would stand up in service for a reasonable length of time. Edison first tried carbon, but when heated to a glowing temperature it was soon dissipated through oxidation. Next he tried burning innumerable materials to produce carbon strands, but the outcome was always the same. At the end of 1878 he turned his attention to platinum and iridium. These metals were found to last longer than carbon, but they, too, melted in a comparatively short time. Realizing that he must exclude as much oxygen from the lamp as possible, Edison began evacuation experiments, but the degree of exhaustion that he could get with the ordinary air pump then available was not sufficient to give satisfactory results.

THE BEGINNING OF ELECTRONICS

While seeking to improve the incandescent lamp in 1883, Edison discovered that when a wire or metal plate was placed between the legs of the filament in a bulb, electricity would pass between the two elements. Such a plate could, consequently, be made to serve as a valve to control the flow of the current. This phenomenon, which became known as the "Edison effect," is the foundation of the modern science of electronics.

About August, 1879, he obtained a mercury pump that would exhaust the air in the lamp to about one one-hundred thousandth of its original volume, and in the beginning of October he was able to carry this evacuation still further. That was made possible by his invention of a one-piece, all-glass globe that could be hermetically sealed. He produced a platinum-iridium filament lamp that had good lasting qualities, but he realized that it was not practical and went back to experimenting with carbon. On October 12, 1879, after many patient trials, he carbonized a piece of sewing thread bent into a loop and sealed it in a glass bulb from which all but an insignificant fraction of the air had been exhausted. When put on the circuit, the filament glowed brightly and continued to give out light for 40 hours before failing. Hence that date is considered to be the one on which the modern incandescent lamp was born.

Not only did the filament possess the necessary stability, but the light met other conditions that made it commercially practicable. It had a small radiating surface and required only a small amount of current to operate it. Before the end of the year 1879 hundreds of these lamps had been made and put in use in the laboratory, on the streets of Menlo Park, and in some of its residences. On New Year's Eve special trains were run there so that people might witness this unbelievable new form of illumination that was to replace gas lights.

The incandescent lamp and many other things that Edison worked on had been visualized by others. The phonograph, on the other hand, was an entirely original conception and that may explain why he liked it more than any of his other inventions. He got his inspiration for it while experimenting with the automatic telegraph. As amazing as its conception is the fact that his first instrument, although crude, performed successfully.

Edison had put aside his phonograph to develop the incandescent lamp, and then came busy years installing lighting

systems throughout the country. He did find time, however, to discover the so-called "Edison effect" in 1883 and thus pave the way for the whole new science of electronics, which right now is reaching a flourishing stage. He also built a new and greater research laboratory at West Orange, N. J., to which he moved his talents and tools in November, 1887. There, after a lapse of ten years, he applied himself to the phonograph. During the next four years he took out more than 80 patents on improvements both on it and its counterpart, the businessman's dictating machine.

During this era he became interested in motion pictures, again making a journey into a field that had remained virtually untouched by the mind of man. Eadweard Muybridge and others had hinted at something of the kind, but that was all. Muybridge had set a series of cameras at different points along a racetrack to take successive photographs of a trotting horse, but he had not conceived the idea of viewing them in a manner that would create the illusion of motion. Edison, on the other hand, envisioned a camera that would take pictures in rapid sequence, and was aided in that effort when George Eastman developed a new celluloid film that was adaptable for the purpose.

Edison thought of the motion picture as something that would do for the eye what the phonograph did for the ear. That he visualized the two together is proved by the fact that his first movie was actually a "talkie," being accompanied by synchronized sound from a phonograph. He applied for a patent on a motion-picture camera on July 31, 1891. The first commercial showing came three years later with the opening of a "peephole" Kinetoscope parlor at 1155 Broadway, New York City. Commercial projection of movies as we now know them was inaugurated on April 23, 1896, at Koster & Bial's Music Hall in New York City. Several men developed projection machines. Edison considered Thomas Armat's to be the best and acquired the rights to it. Improving it, he called it the Vitascope; when he had added sound, it became the Kinetophone. He introduced that machine commercially in 1913, or fifteen years before Hollywood started making sound movies.

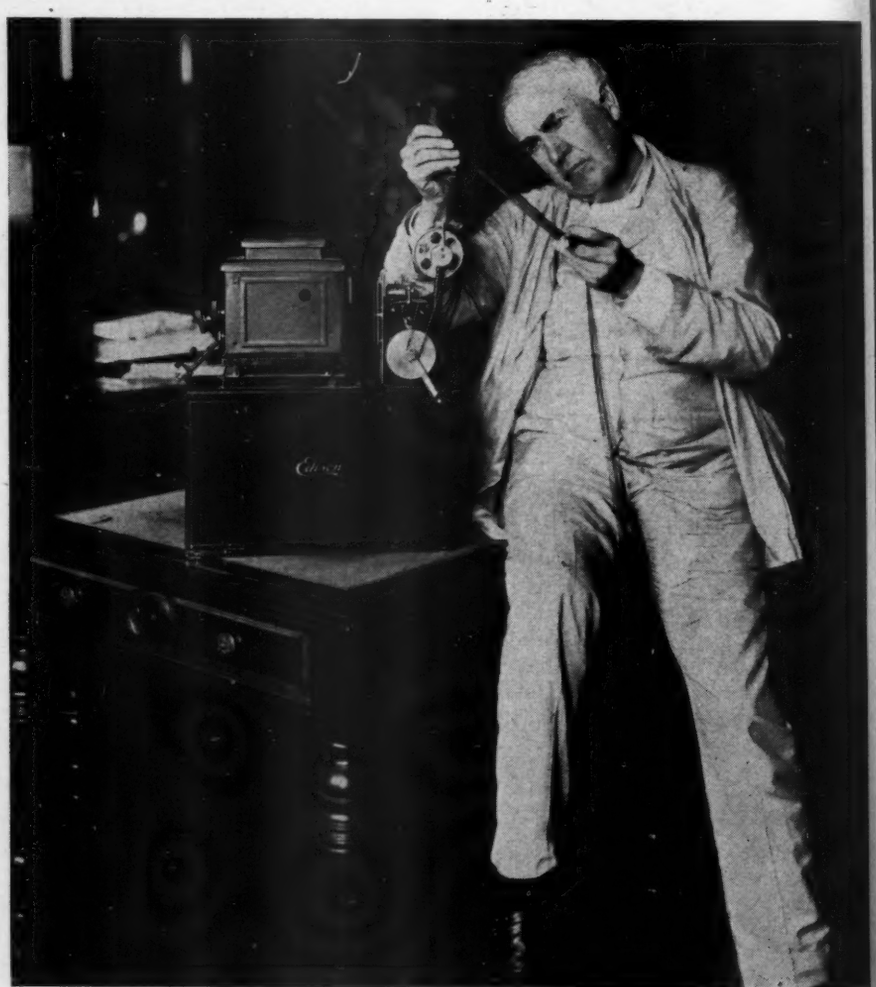
Following Roentgen's discovery of the X-ray in 1895, Edison developed the fluoroscope, and soon came along with the first fluorescent electric lamp. His next major effort was the creation of an acidless battery, which was generally considered impossible. After ten years of experimentation he produced the alkaline storage battery, which today has hundreds of industrial applications.

The first World War made demands upon Edison's talents, and he was equal to them. When carbolic acid became a scarcity in this country after the shutting off of European supplies in 1914, he devised a way of making it here and was providing a ton a day within a month. America was also dependent upon foreign sources for fundamental coal-tar derivatives essential to many industrial processes and the manufacture of explosives. To meet the need, Edison established plants for their production, thus laying the foundation for our present extensive coal-tar chemical industry.

At the request of Josephus Daniels, then Secretary of the Navy, Edison organized and headed a Naval Consulting Board. He gathered other leading scientists around him and also made available to the Government his laboratory facilities. The board turned over to the Navy such significant inventions as devices and methods for detecting submarines by sound from moving vessels, for spotting enemy planes, and for locating enemy gun positions by range finding, as well as torpedoes of an improved type, a high-speed signaling shutter for searchlights, and underwater searchlights.

Honors of all sorts were conferred upon Edison. He liked them and accepted them, but did not seek them. Always he showed embarrassment when receiving them. On October 20, 1928, the greatest tribute of all was paid him. That was the presentation of the Congressional Medal of Honor, the nation's highest recognition for services rendered. A year later, the observance of the fiftieth anniversary of the invention of the incandescent lamp was attended by world leaders, including President Hoover, Henry Ford, and Albert Einstein. Edison was past 80, but his creative mind was still at work. Remembering the nation's shortage of rubber during World War I, he set about devising a process that would enable us to produce it here in the event of another war. Before death came to him he made rubber from goldenrod grown in his experimental gardens at Fort Meyers, Fla.

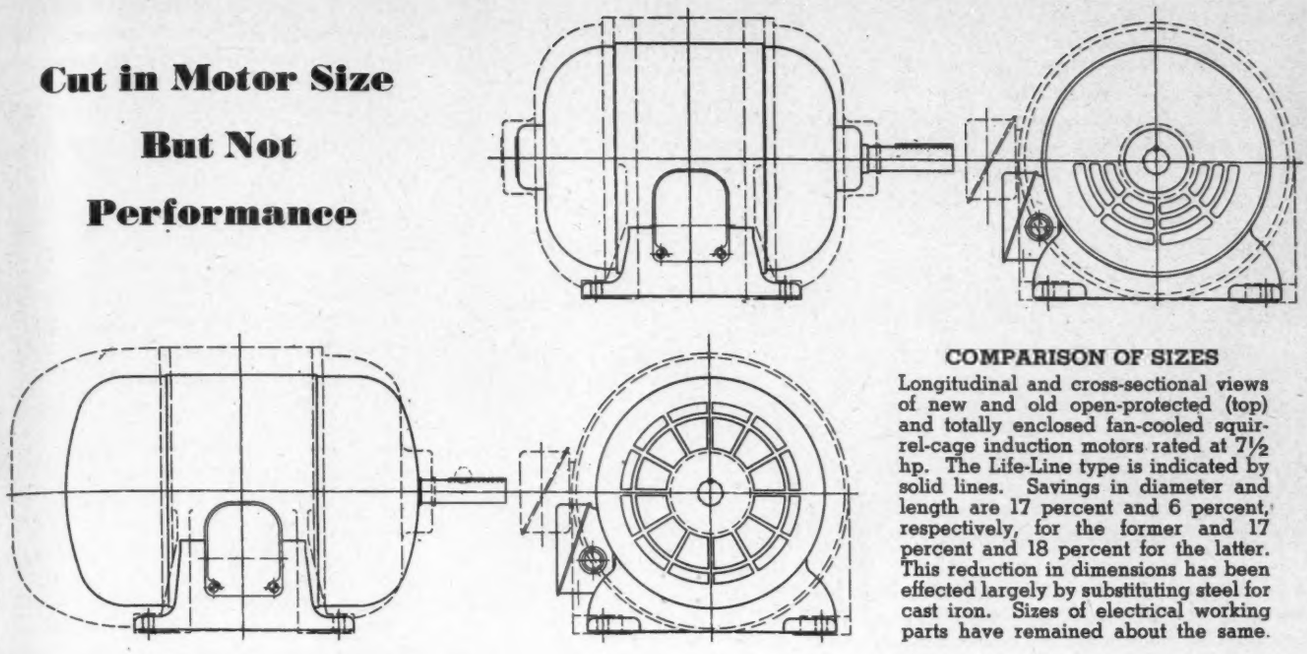
For many of the facts in the foregoing article and for the illustrations grateful acknowledgment is made to the Thomas A. Edison Centennial Committee.



MOTION-PICTURE CAMERA

Edison is shown here examining the celluloid strip photographic film invented by George Eastman that made possible the development of the motion-picture camera. Movies were first projected experimentally on October 6, 1889, and commercially on April 14, 1894.

Cut in Motor Size But Not Performance



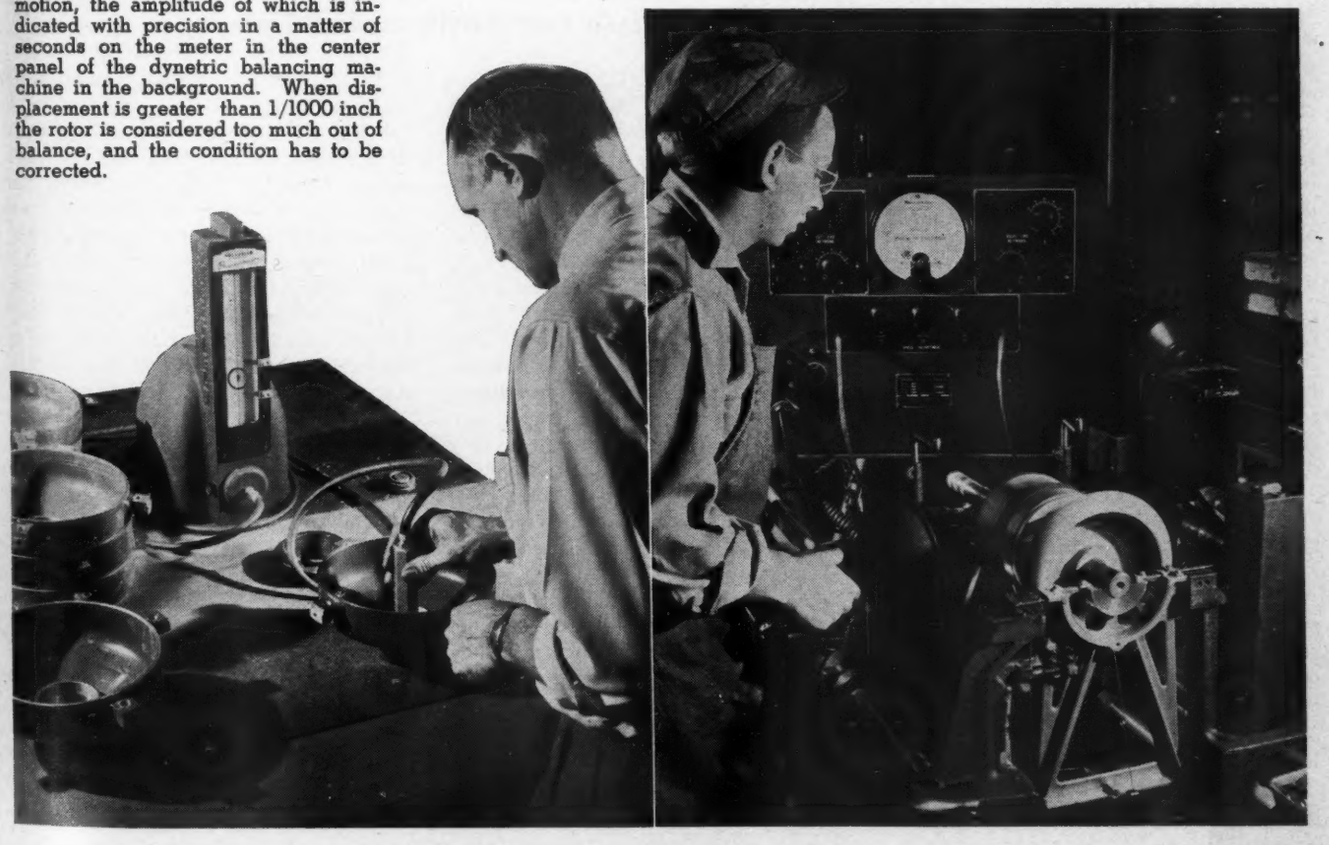
COMPARISON OF SIZES

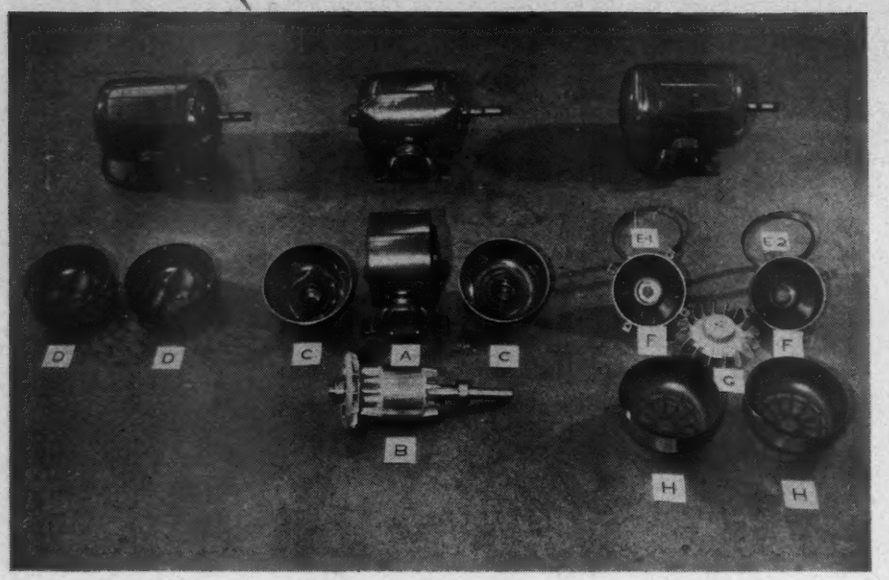
Longitudinal and cross-sectional views of new and old open-protected (top) and totally enclosed fan-cooled squirrel-cage induction motors rated at 7½ hp. The Life-Line type is indicated by solid lines. Savings in diameter and length are 17 percent and 6 percent, respectively, for the former and 17 percent and 18 percent for the latter. This reduction in dimensions has been effected largely by substituting steel for cast iron. Sizes of electrical working parts have remained about the same.

NEW materials, methods, and tools, together with intensive engineering research, have resulted in the development of an alternating-current motor that is a marked step forward, according to a recent announcement by the Westinghouse Electric Corporation. The unit has been given the name of Life-Line and is considerably smaller than the company's 1945 squirrel-cage induction motor. Taking a 7½-hp. machine of the open-protected type, for example, the saving in size is 35 percent; in the totally enclosed model it is 44 percent. These drastic reductions are accompanied, it is claimed, by improvements in electrical and mechanical performances and have been largely effected by the use of steel instead of cast iron and by an improved cooling system that permits the circulation of a greater volume of air. Because formed steel parts can be held to dimensions with more accuracy than iron castings, al-

PRECISION MANUFACTURE

The diameter of the bearing bore in every end bell is checked with an air gauge to assure a snug fit, as pictured below. The permissible minimum to maximum variation is 0.0007 inch. The extent of the variation is shown on the gauge by the position of the indicator, which is encircled for identification, and depends upon the volume of air escaping between the plug in the operator's right hand and the bore of the bell. At the right, a rotor-and-blower assembly is being dynamically balanced to produce a motor that will be as free as possible from vibration. Unbalance is revealed by horizontal motion, the amplitude of which is indicated with precision in a matter of seconds on the meter in the center panel of the dynetric balancing machine in the background. When displacement is greater than 1/1000 inch the rotor is considered too much out of balance, and the condition has to be corrected.





INTERCHANGEABLE

Here are shown the thirteen basic parts and subassemblies for the three types of Life-Line motors now in production. Stator *A* and rotor *B* are common to all three models. When end bells *C* are added, the result is an open-protected machine, as pictured at the top-center. Reorienting end bells so that their openings face upward and adding hoods *D* converts the open-protected unit into a splashproof motor (top-left). At the right is the totally enclosed fan-cooled model which, in addition to the stator and rotor, is made up of blower *G* that is substituted for the smaller fan in assembly *B*; adapter rings *E-1* and *E-2*; end bells *F*; and hoods *H*. All are of drip-proof construction.

lowance for variation is reduced to a minimum and may result in a saving of as much as ¼ inch in 10 inches, diameter or length.

While steel in motor construction is nothing new, the departure from conventional practice in the case of the Life-Line is that the steel sections are as thick as they would be if made of cast iron, also giving the new type increased shock resistance and strength. To protect the metal against corrosion, it is given base coats of baked thermoset varnish and a top coat of lacquer. This finish has been found to be adequate except under severe conditions in chemical plants, when stainless steel is utilized for shields and hoods.

Other factors that have helped to produce an alternating-current motor of smaller size without sacrifice in electrical properties are precision manufacture and pretesting; the use of prelubricated ball bearings throughout; redesigned slot and coil shapes and sizes, as well as connections; wire covered with a special synthetic resin; and an improved winding method. As a result, says the manufacturer, noise and vibration have reached a new low; ball bearings will not need attention for at least five years; maintenance requirements have been much reduced; winding has been made easier; and there is less handling and bending of coils that cause damage, thus minimizing the danger of insulation burnouts.

Another feature of the new design is that one type can be converted to others by interchanging parts, as shown in an accompanying illustration. Production has been started on splashproof, open-protected, and totally enclosed fan-cooled motors in a large new plant acquired for the purpose. The line is at present confined to 2- and 3-phase units ranging in capacity from ½ to 20 hp. and in voltages from 208 to 550, but it will subsequently include the full range of squirrel-cage induction motors that is now being manufactured by the company.

Powerful X-Ray Machine for Industrial Use

IN THE Betatron, industry has, for the first time, an instrument that will enable it to examine castings and forgings for hidden flaws which have defied detection in the past and caused foundries to make certain of their products oversize or overweight so that the weakest sections would stand up in service. The Betatron is a 20,000,000-volt X-ray machine—a voltage that is accepted as the present-day limit and adequate for most industrial needs. It was invented by D. W. Kerst, University of Illinois physicist, and is being constructed by Allis-Chalmers Manufacturing Company.

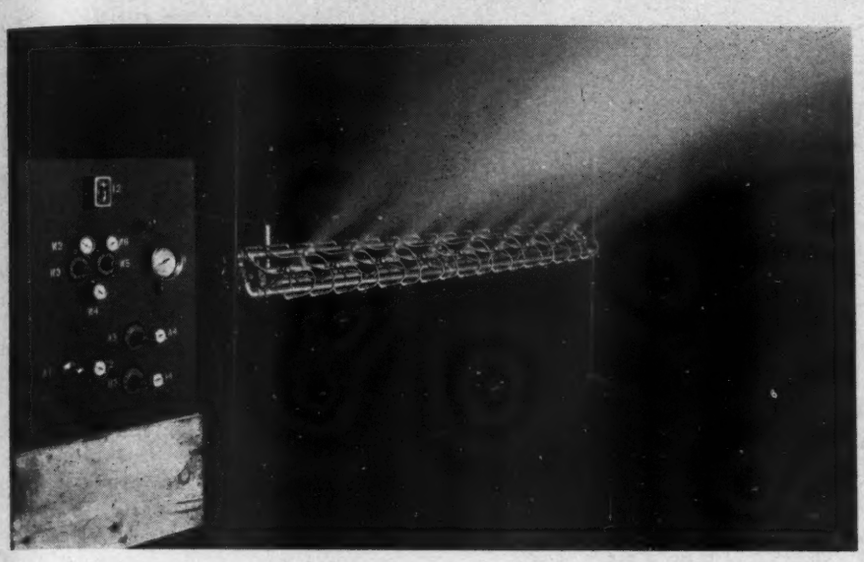
The first unit has been installed at the U. S. Army Arsenal at Picatinny, N. J., and will be used to X-ray shells and rocket warheads more than a foot thick. Its rays are capable of penetrating 20 inches of steel in twenty minutes and of revealing almost microscopic flaws. Because the X-ray source is small in size, it is possible to make direct enlargement of an object by placing the film remote from it. This increases the over-all sensitivity of the radiograph and permits magnification of microparts to three or more dimensions. Further, because there is less scattering and, consequently, less fog than with lower-voltage X-rays, the definition and quality of the radiograph are higher.

The Betatron, in lay language, is a 2-winding transformer with a stream of electrons serving as the secondary high-voltage winding. The latter, instead of being made up of the hundreds of thousands of turns of very small wire that would ordinarily be required to produce 20,000,000 volts, consists of a doughnut-shaped, porcelain vacuum tube containing a sturdy filament and a tiny platinum target. This tube, together with a specially designed circular steel pole piece, is inserted into a small air gap in the center leg of the machine's steel magnet or core.

When myriads of electrons are shot from the filament in the evacuated tube, the magnetic flux acts on them much as though they were moving inside the conventional turns of wire. As the magnet is energized, the flux surrounding the pole piece builds up and causes the stream of electrons to race round and round several hundred thousand times and at a rate finally approaching the speed of light. All this takes place in 1/720th of a second! At the peak of their travel, current from an electronic circuit upsets the magnetic field and causes the electrons to spiral off and collide with the tip of the small target. The energy given off by the electrons in their collision with the target generates a supply of high-frequency X-rays which penetrate and emerge from the walls of the vacuum tube as though it were nonexistent.

Thus the Betatron, by combining a transformer winding and an X-ray tube, becomes a highly efficient tool for the scientific worker and industry. With it, to mention but one of its applications, it will be feasible to examine heavy castings and forgings on a laboratory or production-line scale and to reject even those that have the most minor imperfections, thus eliminating the present practice of oversizing. Through study of the defective parts it may be possible to redesign them with a view to reducing their weight to a point where they will still serve their purpose with an ample margin of safety.

Moistening Moving Webs by Air Sprays



SPRAY IN OPERATION

This picture, taken in the manufacturer's laboratory, illustrates the uniform blanket of finely divided particles of moisture that can be produced. The control board is at the left. In commercial applications the spray battery may be mounted either above or below the moving web of paper or fabric being treated, and the distance it is held from the latter and the angle of spraying are adjusted in accordance with the results desired.

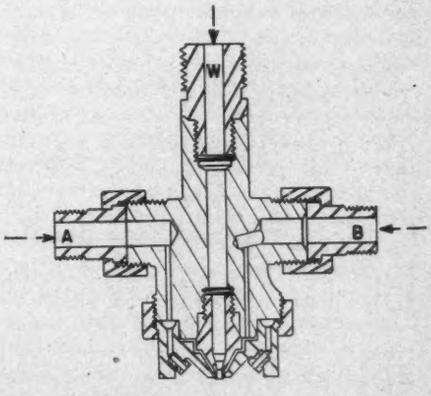
TO MEET a need in the paper and textile industries, Spray Engineering Company of Somerville, Mass., has developed automatic equipment for spraying water and other fluids under accurate control on fast-moving sheets or fabrics. It consists of an assembly of compressed-air-operated atomizing spray heads that distribute a fine spray or mist of uniform density over any given width. Different sizes of spray heads and nozzle combinations provide a wide range of capacities, and controls permit adjusting the volume of the liquid sprayed while maintaining even distribution.

The apparatus was designed in response to requests from the paper industry for suitable equipment to impart moisture to webs of paper traveling at high speed. Water is sometimes added to paper to lubricate it before it enters the calender stacks, to improve the outcome of the operation, and to compensate for any drying the product may undergo. Paper that is to be wax-coated to fit it for such uses as wrapping bread is often moistened to give it greater strength and softness so that it will not easily crack in service. In other cases, its moisture content is increased to eliminate static electricity during printing or fabrication. Papers intended for very fine printing in air-conditioned shops is sometimes humidified to the optimum degree to produce the necessary results.

Different methods of applying the moisture have been tried, including passing the web over wet rolls and putting it on with revolving brushes. None of these has been found to be entirely satisfactory, however, so studies were undertaken by Spray Engineering Company looking towards possible betterments. It was determined that it was desirable to distribute the moisture as a cold mist, free from visible drops, with unvarying density across the entire width of the web and with equipment that would permit precise control of the volume of the water from one or more stations remote from the area of application. These conditions could best be met with air-operated apparatus, and the designs were worked out accordingly.

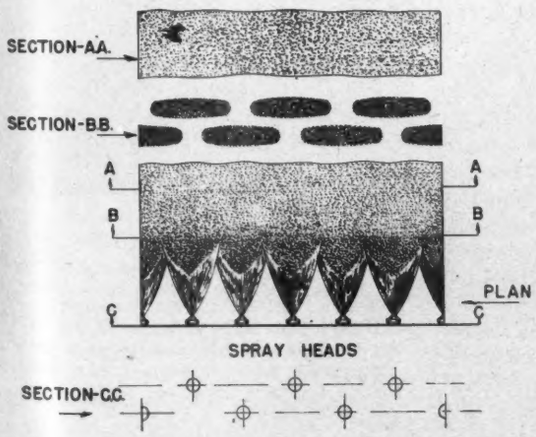
Spray heads are arranged in a staggered line on a supporting bar and spaced from 3 to 6 inches apart, depending upon the volume of fluid to be applied. Each spray head is connected by means of flexible hose lines and individual shut-off cocks with three pipe headers. One hose supplies the liquid and the two others carry compressed air. One of the latter feeds air at 15 pounds pressure to the central orifice of the head to produce the main spray. The latter is further atomized and formed into desired patterns by supplemental jets to which air is admitted from the second line at a pressure of from 8 to 15 pounds, in accordance with the effect to be obtained. The spray heads are normally stationed from 18 to 24 inches away from the surface to be treated, and the battery may be mounted either overhead or underneath. Also, the sprays may be directed perpendicular to the line of the moving material, or at any angle to get the results wanted.

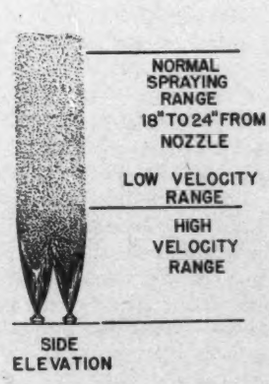
To vary the amount of the fluid applied and to maintain even distribution of the sprays there is provided a control panel with all necessary reducing valves, an air shut-off valve, and a

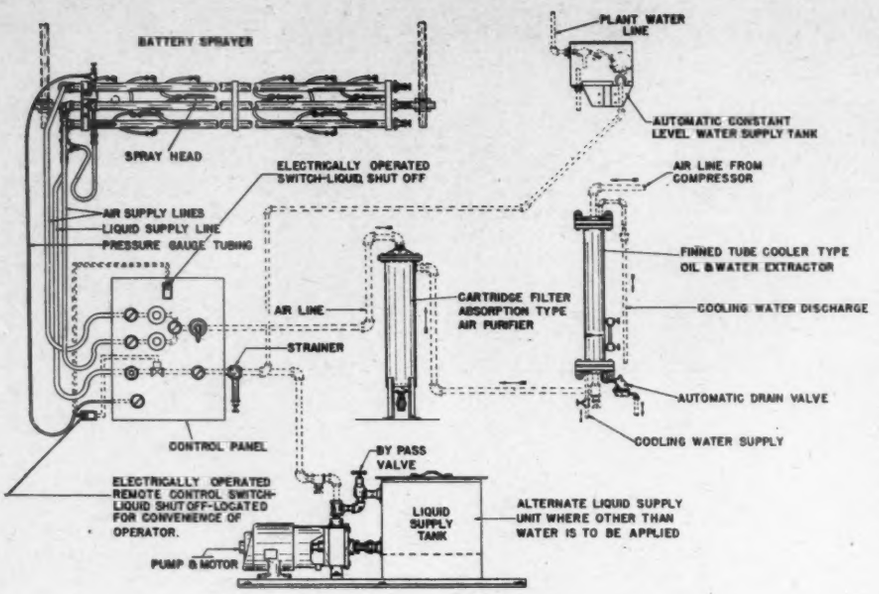


DETAILS OF SPRAYS

Above is a section through a spray head. Air supplied to the main orifice enters at *B* and is under 15 pounds pressure. Further atomization is effected with air introduced through supplementary jet *A* at from 8 to 15 pounds pressure, depending upon the spray pattern wanted. Liquid enters at *W*. The sketches at the left show variations in the mist pattern obtained with spray heads at different distances from the web.






BATTERY SPRAYER
SPRAY HEAD
PLANT WATER LINE
AUTOMATIC CONSTANT LEVEL WATER SUPPLY TANK
ELECTRICALLY OPERATED SWITCH-LIQUID SHUT OFF
AIR LINE FROM COMPRESSOR
AIR SUPPLY LINES
LIQUID SUPPLY LINE
PRESSURE GAUGE TUBING
FINNED TUBE COOLER TYPE OIL & WATER EXTRACTOR
CARTRIDGE FILTER ABSORPTION TYPE AIR PURIFIER
AIR LINE
COOLING WATER DISCHARGE
STRAINER
AUTOMATIC DRAIN VALVE
COOLING WATER SUPPLY
CONTROL PANEL
BY PASS VALVE
ELECTRICALLY OPERATED REMOTE CONTROL SWITCH-LIQUID SHUT OFF-LOCATED FOR CONVENIENCE OF OPERATOR.
LIQUID SUPPLY TANK
ALTERNATE LIQUID SUPPLY UNIT WHERE OTHER THAN WATER IS TO BE APPLIED
PUMP & MOTOR

DIAGRAMMATIC LAYOUT

Air and liquid supply systems. The latter consists of dual equipment for the delivery of either water or some other fluid.

solenoid-actuated liquid shut-off valve. The latter is controlled by either of two push buttons, one being on the panel and the other at some point convenient to the operator's station. Gauges indicate all working pressures.

Air consumption per head ranges from 1.82 to 2.43 cfm., depending upon the size of the unit. Where a plant has an ample supply of compressed air, it may be drawn from the distribution lines. In other cases, a compressor of suitable capacity may be purchased with the spray equipment. To remove oil and foreign matter from the air before application, it is passed through a tube-type cooler and also through a filter. To assure constant liquid pressure and to eliminate air pockets, water is fed by gravity from a tank mounted at least 15 feet higher than the spray battery. Where some other fluid is used, a motor-driven centrifugal pump delivers it at the desired pressure from a supply tank.

When spraying water, it is not important if some of it escapes into the atmosphere; in fact, it is frequently beneficial to increase the room humidity in this way. Accordingly, the spray battery is not housed, and the loss of water may be anywhere within the range of 10 to 90 percent, depending upon the dryness and absorptive quality of the paper, the distance of the spray heads from the paper, and the angle and the fineness of the spray. If a liquid other than water is applied, suitable shields or baffles are erected to prevent its diffusion; and if the fumes are harmful, provision is made for exhausting them.

Although the equipment was designed for spraying water on paper, it has been adapted for distributing emulsions and chemicals on other materials, especially textiles. It was originally employed in paper mills, but it is now being utilized where paper is fabricated into various products like containers. In cases of that kind paper may lose some of its moisture while in storage, or it may be desirable to add moisture in connection with waxing, printing, or other operations.

Air-Activated Storage Bins for Pulverized Materials

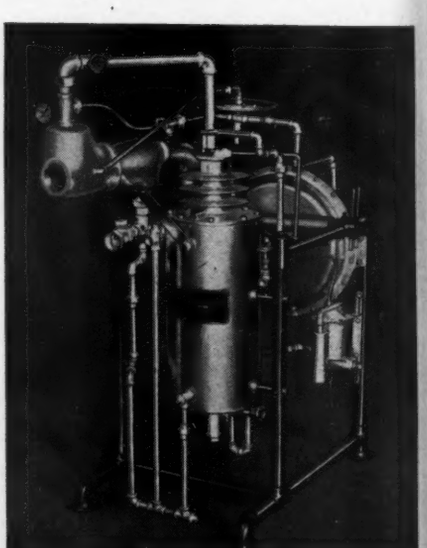
POWDERED or sluggish bulk material held in storage bins for processing is erratic in its action. Sometimes it has a tendency to cake and to rathole, and then again it will avalanche when released. Poke rods and electric vibrators have been used to start the flow, and it has even been the practice to pound the walls of such structures, causing weakening and leakage. These disadvantages are overcome, we are told, by Richardson Scale Company's air-activated bin equipped with a leak-proof control gate that permits the discharge of accurately proportioned quantities.

To insure free flow at all times regardless of the height of a bin, the new design calls for perforated pipes inside the structure. If material jams when gate is opened, the operator shuts it again and manipulates a valve, admitting low-pressure air to aerate the mass and loosen it. The pneumatic system includes a pressure-regulating device and an Aridifier for the removal of moisture from the air. Gates are of special design and, when closed, are sealed tight by means of hog-bristle brushes which also serve to eliminate much of the dust that is usually in evidence where powdered materials are delivered to mixers.

Burns Oil or Utility Gas

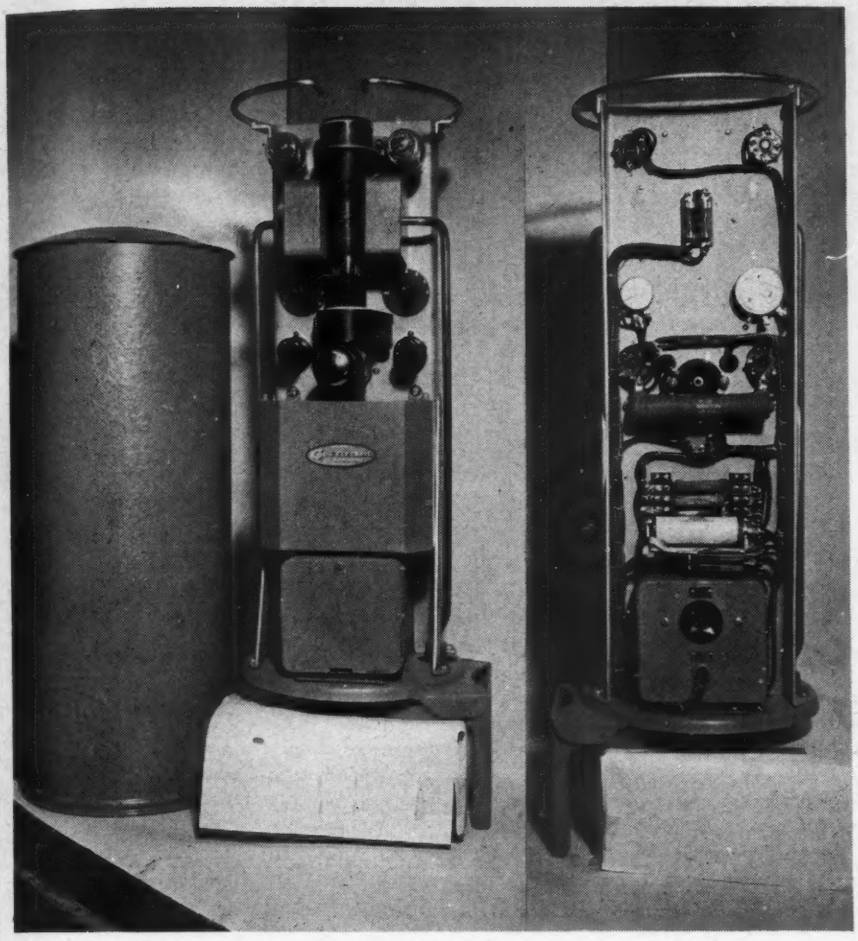
DESIGNED for either fuel oil or utility gas, the improved Vapofier announced by the Vapofier Corporation is described as a dependable unit for industrial processing requiring clean, sootless, and odorless heat at constant temperatures. Consuming oil, the generator produces a vapor (Vap-o-gas) that is mixed with air and piped, controlled, and burned in the same way as any other gaseous fuel. The oil is kept at constant level in the combustion chamber by a float valve and is heated to vaporizing temperature by the products of combustion, which are drawn through the surface of the oil. Before it is fed to the burners the vapor passes through an automatic premixer where the desired fuel-air ratio is maintained. Flame quality may be varied widely from oxidizing to reducing.

Changeover from one fuel to another is effected without service interruption. By simply closing a valve, the oil may be turned off and utility gas supplied instead for admixture with the air. Conversely, in the event of gas failure, fuel oil may be cut in without loss of flame at the burners, or without danger of heat or production stoppage. Eight standard sizes are available with capacities from 70,000 Btu's, or 0.5 gallon per hour, to 2,000,000 Btu's, or 14 gallons per hour. Larger units are built to specifications. Industrial applications of the Vapofier are said to be extensive and to range all the way from baking ovens that should not exceed a temperature of 150°F. to furnaces that have to be heated to 3000° and more.



ADAPTABLE HEATER

Oil-air or utility gas-air ratio is predetermined and maintained by a fully automatic premixer which adjusts itself instantaneously to any variation in service demands without stoppage or change in flame quality. Standard model occupies 2x4 feet of floor or overhead space.



STRAY-CURRENT CONTROL SYSTEM

At the left is the front view of the standard type with the housing alongside. The rear view of the electrical elements is at the right. The system is designed to withstand outdoor-service conditions and is readily accessible for maintenance.

Electric System Curbs Pipe Damage Caused by Electrolysis

IT IS conservatively estimated that damage through electrolysis to water, gas, and oil lines in the United States amounts to more than $50,000,000 annually. This does not include many other underground conduits that are similarly affected. Electrolytic action on such pipe installations has been recognized for years and efforts have been made to minimize it. It is especially severe in areas where there is an overhead trolley wire or third rail and where the car tracks are used as a return circuit to the powerhouse. Not being the best of conductors, and due to varying potentials in the rail, the current sometimes leaves it and enters the ground. This is known as stray current which, using the surrounding soil as a means of conduction, travels to a neighboring pipe line. Following along the latter, the current may leave it because of a varying potential or some obstruction to its flow and attempt to return to the rail on the surface or enter another underground line. At these points of emission from the pipe, especially where the earth is damp, electrolytic action causes such deplating of the metal that the pipe is eventually worn through.

To prevent these damaging effects there has been developed, according to a recent announcement by the Cook Research Laboratories, a Stray Current Control System. It is described as a current and voltage-sensitive device operating jointly on a high-current contactor. The latter is activated by the current and voltage-sensitive device, the functioning of which depends upon the amount of current or potential present in the pipe. When stray current tends to leave the pipe, the contactor closes, thus connecting the pipe and rail by a solid metallic bond on which the current may travel harmlessly. Conversely, the contactor will open instantaneously when the current tends to flow in the opposite direction—from rail to pipe. In this manner the contactor will prevent the system from becoming a back path for more stray current which, if permitted to flow uncontrolled, would result in further electrolysis of the pipe.

The system is now undergoing field tests and will be ready for production shortly. Housed in a standard telephone-pole cable-terminal mounting, it is 26 inches high, 8 inches in diameter, and weighs 40 pounds. This unit does not include the contactor, the size of which will vary with the maximum amount of current that will be allowed through the system. For regular service, the units will be attached to telephone poles, bridges, or any other structures near the points at which electrolysis is deplating pipes. One terminal will be attached to the offending rail and the other to the pipe.

It is claimed that there is no definite restriction as to the range of coverage, which will depend upon the resistance offered by the pipe and rail and upon the distance between the point of connection and the substation which supplies the power.

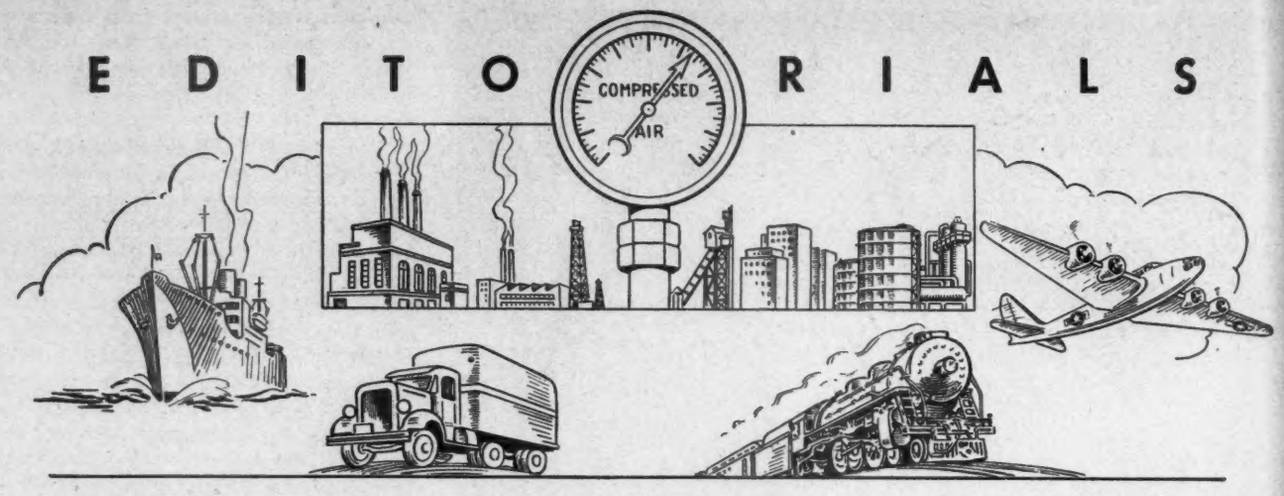
Air Tools for Auto Repair

IN COMMON with other branches of industry, automotive repair shops make extensive use of compressed-air tools and machinery. Many of the methods practiced are well known and call for standard items of equipment, whereas others have been improvised for the tasks at hand. In the latter category are two time-saving operations adopted by the A. D. Rayl Motor Company of Hutchinson, Kans.

To assist in micrometering connecting rods before and during grinding, the firm built in its own shop a small machine that instantly clamps a rod in place and holds it securely. A small air cylinder whose piston moves a plate does the trick. All that is necessary is to put the two parts of a connecting rod in position and open an air valve. The air ram pushes the plate against the head of the connecting rod and holds it tight while it is being micrometered before and during the grinding operation. The machine eliminates the need of screwing on and unscrewing holding nuts.

The same shop uses a small pneumatic chipping hammer for removing and replacing cylinder sleeves. A round disk of steel, about 1 inch thick and a little smaller in diameter than the bore of the cylinder from which the sleeve is to be withdrawn, is set on top of the cylinder. There is a slight indentation in the top face of the steel piece to engage the tool of the hammer. In a matter of seconds the sleeve is tapped out of the cylinder, and the disk follows it. The sleeve is similarly replaced, the procedure merely being reversed.

EDITORIALS



FUTURE MINERAL SUPPLY

MANKIND has unquestionably been wasteful of the natural resources that have been made available to him, and there are good grounds for lamenting the fact. Our petroleum, iron deposits, forests, and even our farmlands have been extravagantly exploited in the past, and this has led to a lot of talk and considerable action looking towards conservation, reclamation, and rehabilitation. This is a meritorious movement and good insurance for the future. And yet, those who predict dire results unless we hasten to overcome our prodigality fail to take into account man's boundless imagination and ingenuity.

So far as our mineral deposits are concerned, it may turn out that the surface has barely been scratched. Virtually all the mines that were developed up to twenty years ago were based on ore accumulations that outcropped at or close to ground level. Prospectors couldn't look into the earth, and they found only those deposits that they could either see or reach by superficial digging. The modern prospector is no longer an individual with a pick and shovel, a burro, and some sowbelly and beans. Instead, a crew of technologists goes out in search with uncanny instruments that reveal underground geological conditions with a high degree of accuracy. Locating ore has gone beyond the needle-in-the-haystack technique. Vast areas can be screened in a few weeks. Deposits that are discovered to be structurally unfavorable to the existence of ore can be disregarded and more detailed investigation confined to those that are structurally promising.

In the actual exploration of sections of the latter kind, the diamond drill is proving an effective ally. A large proportion of Canada's crustal shield is composed of pre-Cambrian rocks that have been rich sources of mineral wealth elsewhere in the world. For the most part, however, they are buried under glacial drift and other surficial accumulations that render old prospecting methods useless. Geophysical devices, on the other hand, can, so to speak, peer through soil overburden and give evidence of what may lie below. Probing with diamond drills then quickly confirms or disproves the presence of ore and also provides actual samples that are a practical means of determining whether mining operations are justified. As a result of these scientific methods during the war more than 40 shafts are now being sunk in Canada to tap mineral deposits that were disclosed by them and were definitely found to be of a nature to warrant exploitation. Deep diamond-drill holes in the Orange Free State, South Africa, have similarly revealed important gold-bearing veins that apparently represent a continuation of the Transvaal's famous Witwatersrand formation.

Doubtless there are many other mineral deposits hidden from view that will be located and mined as fast as the technological investigators can get around to them. For example, the continents that lie under ice in both polar regions are believed to offer promising possibilities along these lines, and it is no secret that current explorations in Antarctica will include geophysical surveys designed to establish the existence of minerals.

In addition to all the continental areas, we still have the oceans to explore. Approximately 70 percent of the earth's surface is covered with water, and all of it is virtually virgin territory. Much of the ocean bed is too deeply submerged to be reached economically, but vast areas such as the continental shelves lie in shallow waters. Already, oil derricks are working several miles offshore in the Gulf of Mexico, and equally favorable physical conditions are known to exist along a large part of our Atlantic seaboard. Between Florida and the Bahamas, as well as in the vicinity of Bermuda, geophysical investigations are being conducted with the aid of diving bells. In recent months the British have been gathering information about the ocean bed in their waters by means of scientific instruments aboard the submarine *Tudor*. The day may not be far distant when some mining company will start actual development work undersea.

Another great reservoir of mineral wealth is ocean water itself. For countless centuries rivers have been wearing down the land and carrying minerals into the seas. Through evaporation, some of them are present in highly concentrated form, notably common salt which, roughly, constitutes 3½ percent of ocean water by weight. The Chinese have obtained salt from the sea for 5000 years, and it has been a source of supply in various other parts of the world, operations in California dating back to 1852. For some years bromine has been extracted from water offshore from North Carolina, and since 1941 magnesium has been recovered commercially from the Gulf of Mexico at Freeport, Tex.

Inasmuch as virtually every commercial mineral and metal is found in sea water, it requires no great stretch of the imagination to visualize future large-scale operations. Admittedly, most minerals will, for a long time, continue to come from the earth, but meanwhile advances in technology can be relied upon to bring methods of aqueous extraction ever nearer the realm of practicability.

The ultimate potentialities of ocean "mining" operations approach the fantastic. It is estimated that there are 329,000,000 cubic miles of sea water, and on this basis the total amount of dissolved salts is something like 54 million tons. Some elements are present in such minute quantities that their extraction on a commercial scale seems to lie beyond conjecture at the present time. Yet, some way of recovering them as by-products may eventually be found. Take gold, for instance. There is only one-tenth of a pound of it in a million tons of ocean water, but in the aggregate it is computed to amount to 75 million tons. Certainly this is a prize worth winning, and one that may well stir scientists and engineers to do a little superdevising in the years to come.

Castings Made Leakproof for Pressure Service

MICROPOROSITY such as usually characterizes magnesium-alloy castings apparently does not affect their usefulness for the general run of applications, but where they are subjected to internal air, gas, or liquid pressure of 2 to 3 atmospheres they must be leakproof. Castings of this kind for airplane turbosuperchargers, gas turbines and jet-propulsion engines, oil manifolds, compressor casings, etc., are usually tested before service at pressures up to 50 percent more than the operating pressures for which they are designed. Heretofore, when areas were found to be pervious, the parts had to be rejected as inadequate; but now, because of improved sealing solutions and methods of impregnation, the defect can be remedied.

The choice of solutions is wide and includes both organic and inorganic materials; and the processes lend themselves to small-scale or continuous large-scale production. A set-up of the latter kind includes a storage tank with cooling coils to keep the fluid at a temperature below 70°F., an autoclave or impregnator to hold the castings, a vacuum pump to evacuate the autoclave, and a source of compressed air to force the solution into the castings.

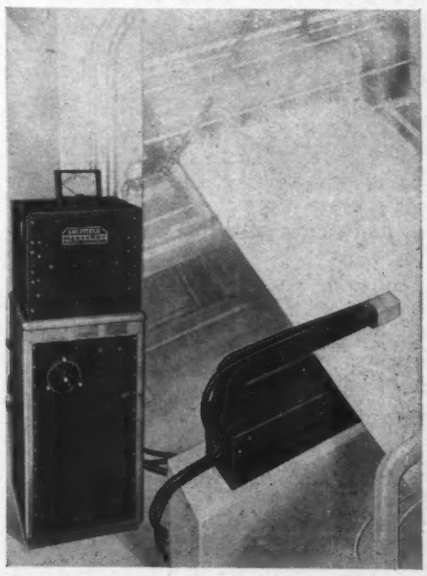
Vacuum of 27 inches Hg. (mercury) or better is applied for 20 minutes to withdraw the air from the impregnator and the pores in the castings. At the end of that period the vacuum is released, the solution is allowed to enter, and air at from 70 to 90 pounds pressure is admitted. This is maintained at from 30 to 60 minutes, depending upon the wall thickness of the castings. Then follows draining, rinsing to remove any excess solution from the surfaces, and heating of the castings for two hours in a closed furnace at a temperature of 275°F. to polymerize the solution in the pores. In cases of exceptional porosity, two impregnations may be required.

Where individual castings are to be treated, the steps before and after impregnation are the same as just described. But after evacuation, all except one of the openings in a casting are plugged, the latter is filled with the solution, and the opening is closed with a cap through which air at from 70 to 90 pounds pressure is introduced and held for at least fifteen minutes, or until the fluid oozes slowly out of the pores. Inasmuch as it has so far not been possible entirely to eliminate microporosity in magnesium-alloy castings, the method of sealing with the aid of vacuum and compressed air will prevent scrapping castings for pressure service that otherwise are physically sound.

Noncontact Thickness Gauge for Sheet Material

AT THE Iron and Steel Exposition held recently in Cleveland, Ohio, The Sheffield Corporation exhibited a gauging instrument that makes use of X rays and electronics for measuring and regulating the thickness of sheet or strip material in process of manufacture. It is suitable for continuous or spot checking and does not require contact with the product being gauged. The equipment is named the Measuray and is a comparator in that it compares the thickness of the moving material with a sample of the same material of the desired, known dimension.

According to the manufacturer, tolerance and thickness limitations depend to some extent on the density of the product. Accuracy may be maintained at better than one percent regardless of changes in the material, rate of travel, and temperature. For example, sheet or strip coming hot from the rolls gives the same indication on the Measuray as when cooled to room temperature. Instrument can be used to gauge thin metal foil or sheets 3/16 inch thick, or a wide range of other products such as film, paper, plastics, rubber, and composition materials. Four standard units are available, the selection being governed by the thickness, density, tolerance, and type of material to be checked. All are equipped with indicating mechanisms, but recording and machine-control devices are available.

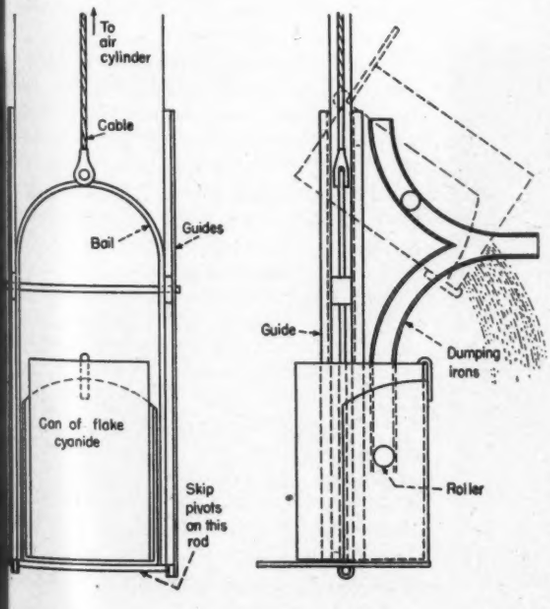


INSTALLATION VIEW

The gauge head may be held any desired distance from the material traveling between the source of the X rays and the detector. The electronic-power and amplification unit (left) is set up wherever convenient. The instrument can be used with most processes in which the thickness of the product has to be measured and regulated. Accuracy better than 1 percent is claimed regardless of room or stock temperature or whether material is moving at the rate of 5 or 5000 feet a minute

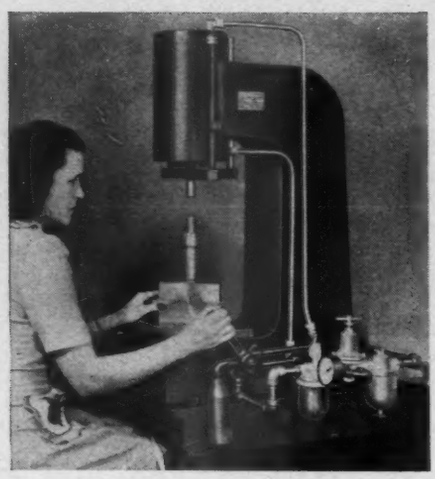
Air-Operated System Dumps Cyanide with Safety

CYANIDE dust and fumes are harmful to humans, and work involving contact with that chemical compound is what might be called an occupational hazard. At the Kerr-Addison Mill in Virginiatown, Ont., Canada, where the material is used in the extraction of gold from ores, hand dumping with its attendant irritating skin rashes has been eliminated. The cans are now handled mechanically by a system that is completely inclosed and controlled from the outside. It consists of a hoist and dump of the kind used in headhouses to empty mine skips, but is on a much smaller scale.



Except for loading and unloading, the operation is automatic. After a can has been placed on the skip and the chamber has been closed, it is hoisted by an air cylinder. At the limit of its travel it is tripped and its contents are dumped into the hopper of a reagent feeder that discharges into conditioner tanks. Reversal of the piston stroke returns the skip to the starting position; but before the empty is replaced by a full container, the fumes and dust in the inclosure are exhausted to the atmosphere.

Industrial Notes



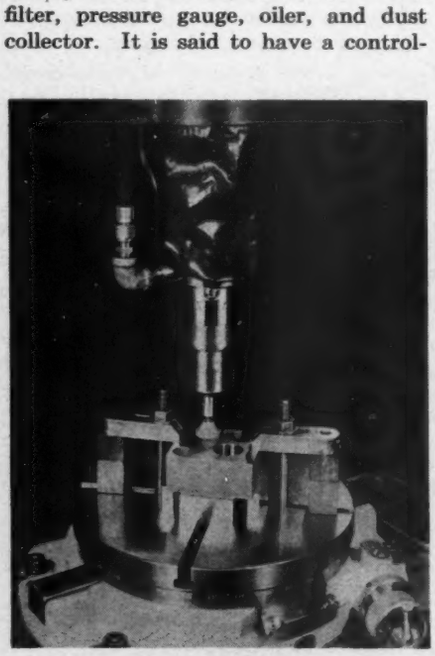
Two new air-powered arbor presses for light push or pull broaching jobs, as well as for assembling, stamping, forming, riveting, punching, cutting, and other work, have been announced by the Studebaker Machine Company. They are known as the Hurricane Six and the Hurricane Eight and are operated by double-acting air cylinders through hand-lever, foot-pedal, or push-button control. Type Six develops maximum ram pressures of 1 ton and 1½ tons, respectively, with air at 80 and 120 pounds line pressure. With the same pressures, Type Eight develops 2 and 3 tons. Both ram pressure and stroke are adjustable: the first from a few pounds to the maximum and the latter from a few thousandths of an inch to 6 inches. This permits a wide range of operations calling either for sharp punch-press blows (up to 200 per minute) or a very slow squeezing action. Being entirely air powered, the new arbor presses can be quickly set up and connected to a shop air line.

Superior lubricating qualities are claimed by The United States Graphite Company, Saginaw, Mich., for its graphite ingot-mold wash. In addition to facilitating stripping, it is said to repel splashed metal, to prevent scabs and inclusions, to be fireproof, and not to give off hazardous fumes. It can be applied at temperatures ranging from 200 to 700°F. by means of a portable air-spray outfit designed by the company and which users can build from blueprints that can be obtained free of charge.

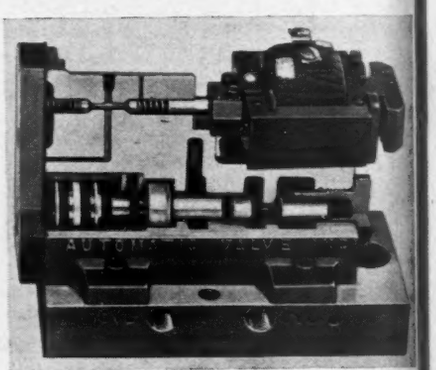
Providing hot water at scattered points in large factories and mills for showers and wash basins is generally a nuisance because it necessitates long pipe lines or separate water heaters. Now Sarco Company offers what seems to be an answer. It is in the form of a steam and water mixer about 26 inches long and 5 inches wide at the head. Tapping a steam pipe, water flows in one side and steam the other, the latter continuing to enter by way of a valve until the water has reached a predetermined temperature controlled by a built-in hermetically sealed thermostat. The latter contains a liquid which expands under heat, shutting the valve by means of a plunger, and contracts when radiation has cooled the mixer, thus reversing the cycle. Accidental overheating is prevented by a relief spring. With steam at 75 pounds pressure per square inch and a temperature rise of 70°F. (from 50 to 120°), unit is said to have a capacity of 200 gallons an hour.

The use of radiant heat to keep sidewalks clear of snow and ice is being tried out in Toronto, Ont., Canada. A firm was granted permission to relay the paving in front of its office building in the heart of the city in order to embed coils of piping in the concrete through which to circulate heat generated in the building. There is every reason to believe that the system will be as effective for that purpose as for keeping delivery entrances of industrial plants open and loading platforms free of obstructing snow the winter through. These applications of radiant heat are a consequence of its increasing use for heating garages, shops, and factories.

After many months of testing and development, the Vulcan Tool Company has put in production a high-speed, air-driven attachment for jig borers and other machine tools that converts them into precision jig grinders. The unit is called the Vulcanaire and is equipped with an adapter, that fits into the chuck of any machine tool, and with an air filter, pressure gauge, oiler, and dust collector. It is said to have a controllable speed range from 30,000 to 75,000 rpm., requiring the consumption of but 4 to 8 cubic feet of air per minute, and to permit grinding holes from 1/16 to 1½ inches. Exclusive of the adapter and the grinding wheel the attachment measures 7½ inches and has a maximum diameter of 2½ inches. In addition to jig grinding, the Vulcanaire is available in models by which lathes and milling machines, as well as internal and surface grinders, can be adapted for high-speed precision grinding.



Automatic Valve, Inc., has announced a new solenoid air valve designed especially for machine-tool operations controlled by air cylinders. It is a 4-way, 4-port unit of the pressure-sealed poppet type with a ⅛-inch solenoid plunger travel. Designated as the Model SV-4, it is described as a compact, lightweight, noncorrosive valve of rugged construction and positive, high-speed



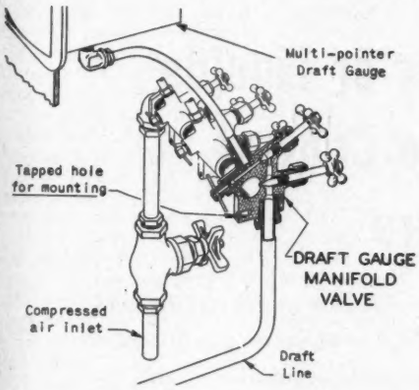
action. Can be mounted in any position close to pneumatic cylinder and serviced without disturbing piping. Unit is available in ¼, ⅜-, ½-, and ¾-inch sizes and with five ports for differential air pressures, 0-150 pounds. All parts of both 4- or 5-port types are interchangeable.

In adding three floors to the Sears, Roebuck & Company building in Los Angeles, Calif., the contractor had to make provisions that were not required in 1929 when the original structure was erected. The present building code specifies that new construction be designed to withstand horizontal stresses caused by seismic disturbances. This is being done by mounting the columns of the superstructure on bearings each made up of two sets of rollers in 21-inch square frames arranged on top of and normal to each other. Each set weighs 600 pounds and can support 125 tons. Acting together, the rollers permit a column to move as much as 6 inches in either direction. All told there are 65 of these sets, which were made by The Torrington Company. An adjoining building, erected in accordance with the

revised code, will absorb the horizontal rockings of the addition through ties at each floor, while the vertical load will be borne by the old structure.

Polystyrene, a plastic, is expanded to 40 times its volume by The Dow Chemical Company to form a low-temperature insulation that, because of its multicellular structure, is moisture resistant as well. The name of the new product is Styrofoam.

Production of the Parker Appliance Company draft-gauge manifold valve, manufacture of which was suspended during the war years, has been resumed, according to a recent announcement. This power-plant instrument auxiliary is designed to simplify the work of blowing out draft lines in multipointer draft-gauge installations. The manifold is permanently connected to a source of compressed air and consists of two



valves. One of these shuts off the meter line while the other allows the air to flow through the draft line to remove fly ash. In general service, the meter valve can also be set to give any desired dampening of the pointer it serves. The manifold units are assembled in multiples to correspond with the number of draft-meter pointers, thus eliminating makeshift rubber hose and, by making it easy to blow out the lines, safeguarding against neglect of this necessary operation. A zero-check plug is incorporated to facilitate testing the instruments. The draft-gauge manifold valve is reversible, permitting mounting whether draft line runs up or down from the instrument panel.

Electrolytic action with its destructive effect on steel water towers and deep-well pumps is eliminated, it is claimed, by the use of a cathodic rectifier built by Trimount Instrument Company. The equipment is housed in a weatherproof cabinet, and standard type operates on 110-volt, 60-cycle alternating current. Under normal conditions such a tank or pump acts like a primary battery with the submerged part forming the anode, which is sub-

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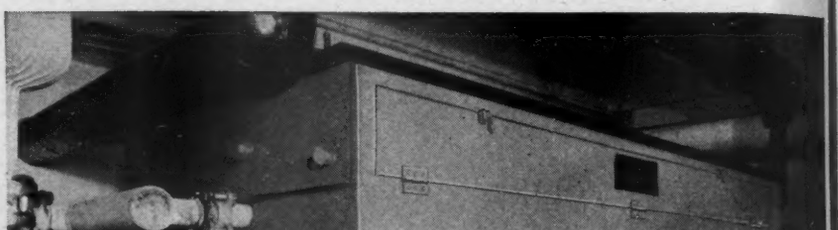
ject to rapid rusting and pitting. With the rectifier, however, the metal of the tank or pump becomes the cathode which is charged by the rectifier, thus reversing the flow of the current and protecting the installation against corrosion.

Insulating tubing of Fiberglas is being offered by Bentley, Harris Manufacturing Company, Conshohocken, Pa., in standard sizes and in the required colors for circuit identification. Claims made for it are that it will not crack or split at bends, will remain flexible, and is noncombustible. The product is known as Ben-Har tubing and is available in two grades with a dielectric strength of 5000 to 7000 volts and 2500 to 4000 volts, respectively. The company is prepared to furnish samples.

When trees begin to shed their leaves, street-cleaning departments, especially of suburban communities, have their hands full. To expedite the work, the American Structural Steel & Tank Company has designed a vacuum cleaner mounted on a 2-wheeled trailer. With the intake pipe traveling close to the gutter, the equipment sucks up wet or dry leaves, along with other debris and small stones, and deposits them in the screened-in collection truck to which it is attached.

Metallizing and welding with one unit is the unique feature claimed for a gun named Spraywelder developed by the Wall Colmonoy Corporation. The unit first serves to apply a layer of powdered metal and is then used like a conventional welding torch to fuse the material with the base metal to form a molecular bond. Powder flow is adjustable and is started and stopped by a trigger. The gun is of light weight for hand operation, or can be held by means of an attachment or, in the case of a lathe, by the tool post. It is designed for use with the Colmonoy Sprayweld process, but is suitable for applying other than the company's special alloy.

Wood used in making cab framing for trucks built for service in semitropical and tropical regions is pressure treated by one manufacturer to give it resistance to decay. The various parts are first preformed of 1-inch lumber that is bonded together where thicker sections are required with phenolic-resin glue, which is proof against decay and mildew. Following assembly, the wood is impregnated with a solution of pentachlorphenol in light oil applied under air pressure. Trucks with such cab framing are being used in the Hawaiian Islands, and the treatment is said to give the wood three times the life it would normally have under those climatic conditions.



Chilling Water or Liquids With Accurate Control of Temperature

Regardless of either variation in the cooling load or intermittent operation, the new Niagara Liquid Cooler holds the delivered temperature accurately at the required point. It will deliver fresh water at 33°F. constantly without danger of freezing damage and produces lower temperatures accurately in non-freezing chemical liquids and solution.

Capacity range in available models is from 24 to 465 gallons per minute. High capacity and fast chilling are provided in extremely compact space. The cooler is reliable and easy to maintain; all parts are accessible for cleaning; insulation is easily applied; operation is economical of power and refrigeration.

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Industrial Literature

Hard hats for every worker who is exposed to possible head injuries are described in a new bulletin, *M. S. A. Skullgards*, issued by Mine Safety Appliances Company, Braddock, Thomas and Meade Streets, Pittsburgh 8, Pa.

Norton Cylindrical Grinders is a broadside that presents in many pictures and few words the machines in this category made by Norton Company, Worcester, Mass. It enumerates descriptive catalogues covering each type that may be obtained by those interested.

Hercules Powder Company, Wilmington, Del., offers a new technical bulletin on Parlon, a chlorinated rubber product originally intended as a base for paints for coating concrete and other surfaces exposed to the action of chemicals, gases, mold growths, and other destructive agents. Now it is also used in inks, paper coatings, and textile finishes. Manufacture of Parlon has been resumed after suspension during the war years because of the shortage of natural rubber.

Centrifugal pumps for handling acids, alkalies, and other liquids commonly used in the general chemical industry are described in a new bulletin—*Chemical Pumps*, Form 7095—issued by Ingersoll-Rand Company. All parts that come in contact with the fluid pumped are ordinarily made of Ircamet, a corrosion-resistant nickel-chromium-molybdenum steel, but they can be furnished in other metals to meet specific services. This line is made in five classes. The range of sizes in four of them covers capacities up to 1500 gpm. at temperatures up to 275° F. The fifth includes large-capacity pumps and is offered in sizes for handling up to 4000 gpm. of either cold or hot liquids. Temperatures of the latter may range up to 800°. Copies of the Bulletin, *Chemical Pumps*, may be obtained from the company's general office at 11 Broadway, New York 4, N.Y., or from any of its branch sales offices.

New Book on Rock Tunneling

Only two books of any consequence on rock tunneling have appeared in this country in the past twenty years. The most recent one, *Rock Tunneling With Steel Supports*, is published by The Commercial Shearing & Stamping Company of Youngstown, Ohio. Its joint authors, R. V. Proctor and T. L. White, are with that firm, the former being vice-president and general manager and the latter chief engineer of design. The introduction, dealing with tunnel geology, is by Karl Terzaghi, consulting engineer and a lecturer on engineering geology in the Graduate School of Engineering, Harvard University. The volume consists of 271 pages and is well illustrated. It sells for $2.50 a copy.

Although it makes good reading for anyone interested in tunneling, the book is intended for practical use by those that are charged with designing and excavating tunnels and especially with bores which penetrate ground that has to be supported in places or throughout. Various types of "bad" ground are considered, and methods of dealing with each one are described in detail.

The fact that this treatise is sponsored by a concern that manufactures metal supports adds to its value because its authors are in a position to bring to bear on their subject an accumulation of first-hand information. Having met and coped with the problems discussed, they are able to present this information in the way the practical tunnel driver wants it.

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